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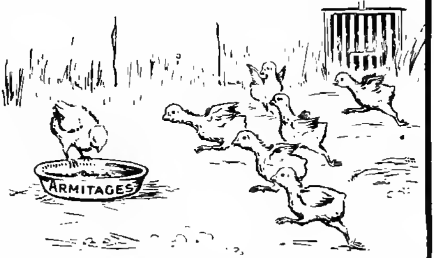

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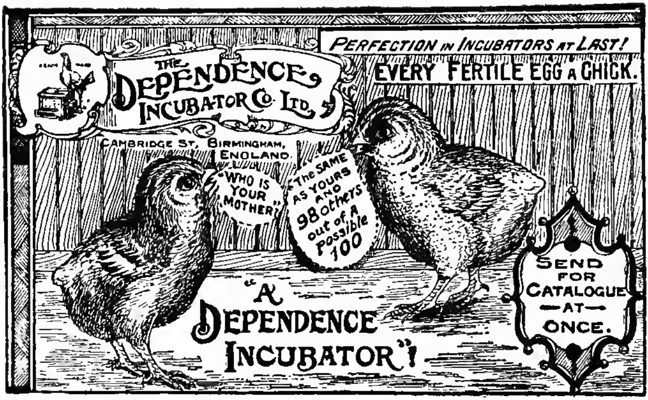

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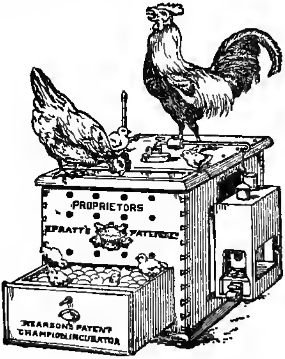

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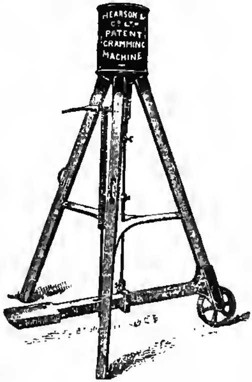

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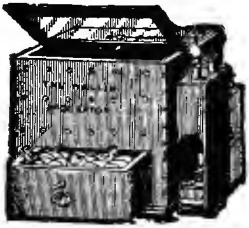

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PREFACE.

In this small volume an attempt is made to deal, more or less fully, with the science and art of incubation. Although there are already many pamphlets published by incubator-makers, each detailing the working and showing the advantages of the particular machine in which they are interested, no effort is made in any of these to explain the reasons for the various essential features of a good incubator, or the principles by which they are guided in its construction. The following chapters contain just such information as I should have been glad to have placed in my own hands when I first became theoretically and practically interested in the subject of incubation.

It is hoped that my readers will not only find sufficient information in this book to guide them in the selection of an incubator, but also, by gaining a more competent knowledge of the sciences involved, be able to secure better results from the incubators already in use.

Many new drawings have been introduced, illustrating the development of the embryo, appearances of fertile and addled eggs, &c.

It will of course be understood that in the chapters describing various incubators and brooders, I am not professing to notice every kind that is sold, but only such of them as seem to me to be the most noteworthy. Several makes which were very prominently before the public at the time of writing the previous edition of this book are not now being manufactured.

J. H. S.

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INCUBATORS AND THEIR MANAGEMENT

CHAPTER I.

NATURAL INCUBATION.

MATING.

Poultry-keepers would often save themselves the disappointment of poor hatches, if greater care and discrimination were used in the mating of their birds with a view to ensuring fertility in the eggs and vigour in the chicks. Of course, in mating birds for exhibition purposes, the greatest skill, care, and judgment are demanded; but even in mating ordinary stock for laying or table purposes, considerable care is necessary if a high percentage of vigorous chicks is to be attained. It is folly to expect fertile eggs or strong chicks from the ill-kept and ill-conditioned specimens that are sometimes used for breeding purposes.

Space does not permit of my entering fully into the subject of mating. Suffice it to say, that the fowls, but specially the cock, should be strong and vigorous. Perhaps the best results are got from two-year-old hens and a cockerel. It is not wise, where there is a choice, to use pullets. As so much depends upon the cock, which should be of a pure breed, whatever cross the hens may be, he should be carefully watched, especially on coming out in the morning and after the evening meal, to see if he is active, as the hatches of a whole season may be spoilt by failure in this quarter.

THE SITTING HEN.

When a hen manifests a desire to sit, it is advisable when possible to allow her to do so, as a market can generally be found for the chickens if they are not required at home, and repeated checking of the desire to incubate cannot fail to be injurious. All hens have, at some time, possessed this natural desire, but a long course of selection by breeders has eradicated it in some varieties, which now rarely or never evince these maternal propensities. To preserve such breeds, their incubation must be undertaken by other fowls. Amongst the chief non-sitters are Minorcas, Leghorns, Andalusians, Hamburghs, Houdans, and Polands, although, occasionally, in old hens of these breeds, this natural instinct may assert itself. The chief broody kinds are all varieties of the Dorking, Game, Plymouth Rock, Wyandotte, Brahma, Langshan, and Orpington.

Characteristics of Sitters.—When choice can be had, a broody hen is best with short legs, for these are not so liable to cramp with the sedentary occupation. Large wings and plenty of feathers are also advantageous in the better covering of the eggs, and the keeping of them at a more uniform degree of heat.

"Checking Broodies."—If it is not convenient to set a broody hen her natural desires may be checked. There are several foolish and cruel methods of doing this which are sometimes adopted, such as confining her in a closed, dark coop without food or water. This may have the effect of stopping her broodiness, but it also has the effect of so lowering and weakening her physical condition, that it may be many days before her strength returns and she begins to lay again. A much better plan is one recommended by W. Cook in his "Poultry Breeder and Feeder," and which is here given. Get a box of suitable size and about 20in. deep—if roomy enough to hold several hens all the better. Place vertical bars about 2in. apart in front, and for the bottom nail stouter bars 3in. apart. Rest this coop on, say four bricks, to raise it a few inches from the ground. A hen in a coop of this construction, as will be seen, cannot sit, but is compelled to perch. To keep the bird in condition during its imprisonment, place the water and feed all the hens of the yard in front of the coop, taking care that the broody hen gets as much as she desires. In this way she is soon cured, and being in good condition, commences to lay without loss of time.

SITTING-BOXES.

It has been noticed that a hen laying away and setting herself almost invariably brings off a large brood of strong chicks. We conclude, therefore, that the nearer one can copy these natural conditions, the better results will be obtained. The ordinary henhouse is not a good place to set a hen, owing to the disturbance and annoyance to which the sitter is subject from the other occupants. It is, moreover, often too dry.

Making the Nest.—One good plan is to set each hen in a separate bottomless coop on the ground outside, unless very early in the season when the weather is extremely cold. Cover the ground inside the coop with a good supply of fine soil, carefully removing any small stones. Shape the nest into the form of a saucer, but not too deep, in which case the eggs are liable to get cracked by concussion when being turned by the hen, an operation which she instinctively performs daily. Take care also the four corners of the coop are filled up to obviate the danger of an egg rolling into one of them. Next place a good covering of hay or bruised straw, cut into short lengths, the latter preferably, as it is less liable to harbour vermin, though hay has the advantage of being warmer for use early in the season. When the nest is complete, scatter a quantity of powdered brimstone over it, and it is ready for the hen. Some people recommend a cut turf instead of soil, but the former is apt to get dry and hard during the three weeks' incubation.

Wired Runs.—In front of the coop, it is a good plan to have a small wired run, in which are placed food and water, and, if possible, a box of dry ashes for a dust-bath. The hen can then be left almost entirely to herself during the whole incubation period, as she can come off and go on as she wishes. As she cannot get away, there is no fear of her returning to the wrong nest, while, being always within sight of her eggs, there is little danger of her remaining off too long. If an ordinary coop with bars be used, the barred front should be covered, except a hole large enough to enable the hen to enter, as she will sit better in semi-darkness.

A Home-Made Sitting-Coop.—When economy rather than architectural beauty has to be studied, a sitting-coop can easily be made from a fair-sized box. Place it upside down, that is, with the open top to the ground; take off carefully what is now the top, to form a lid which can be hinged to open upwards by two pieces of stout leather. A hole, about 9in. deep by 8in. wide, for an entrance in front, with a few ventilating holes round the sides near the top, complete it. If there is, however, any danger of rats, &c., burrowing under the coop to the eggs, it may be necessary to nail on the bottom some ½in. wire netting, and to provide a door for the entrance. Also, if the lid is not waterproof, it should be made so by a covering of some impervious material, as felt or even tarred brown paper. The run, which need not be more than 3ft. or 4ft. by 2ft., and 15in. high in the middle, can also be made easily and cheaply by any handy man.

CHAPTER II.

TREATMENT OF SITTING HENS.

However many hens are set at one time, no better method can be adopted, or one more closely approximating the natural conditions, and at the same time having the fowls under control, than that of providing each sitter with a separate coop and run. If, however, the cost or trouble of making these runs be considered too much, one run might suffice, giving the hens their daily exercise in turn by moving the run from coop to coop. After fastening up one hen, remove the run to the next, gently lift the hen off, and, as she cannot get away, she may be trusted to return to her work. In this way every hen would get her turn during the day, and no time need be lost in seeing them safely back to their nests.

Another plan, and one sometimes adopted by gamekeepers in hatching pheasants, is worthy of being mentioned. It consists of tethering, by means of pieces of string, each hen to separate sticks driven into the ground at convenient distances apart. To each stick is fastened a piece of string about a yard long, with a loose noose at the end. Every morning the hens are taken off, the loose noose is slipped over one of their legs, and food and water are placed within reach. After the first day or so the hens submit quietly to this performance. All this means trouble, but not so much as at first sight appears, as the daily airing to all the sitters is given at one time, and there is no anxiety as to whether the birds will get back duly to their proper places.

A fourth plan is to have one run only in front of all the sitting coops. In turn, during the day, liberate one hen at a time. Leave her to return at her own leisure. At the next visit close the door of the open coop and release the next sitter.

Dusting the Hen.—While sitting, the hen and sitting-box should be dusted once or twice with insect-powder or powdered brimstone, as hens are sure to be restless and sit badly if troubled with vermin, or sometimes will forsake their eggs altogether.

Airing the Eggs.—A sitting hen should be allowed off ten to twenty minutes once a day; or, if she is at liberty to come off into a close run, she may be left much to her natural instincts, as the less she is interfered with, probably the better will be the result. Some hens sit too closely, and will not leave the nest for two or three days at a time. These birds need to be protected against themselves, and should be gently taken off at least every other day. It is a bad practice to place food and water within reach of the hen while on the nest, unless she shows a disposition to come off oftener than needful. When this is done, some ardent sitters will hardly come off at all, and, as I shall show in another place, the eggs as well as the hen need regular airing.

Broken Eggs.—The eggs should be examined when the sitters are off, and should any have been broken, the others will be smeared, and the nest soiled. These eggs should be washed with a cloth and warm water, and thoroughly dried before being replaced. The nest should also be made clean again. If the eggs are replaced while wet, the water, in the act of evaporating, absorbs heat from the egg, thereby chilling it.

Food.—When a hen becomes broody, it is usually in a good condition and fat, thus having a reserve of animal heat with which to bear the strain of three weeks' incubation. The best food is Indian corn, with a supply of water, green food and grit. Hard corn has many advantages over soft food: it is more convenient, more gradual in its digestion, and, consequently, sustains the body for a longer period. This presupposes a supply of sharp grit with the corn. The food should be varied, as a change of diet from time to time is as acceptable to poultry as to human beings. The aim during incubation is to keep up the heat of the hen's body, and Indian corn is about the best as a staple food for this purpose.

Period of Incubation.—Twenty-one days is the usual incubation period of hens' eggs under natural conditions; but the actual period of incubation varies considerably. The development of the embryo chick can be hastened or retarded within certain limits, just in the same way as the gormination of a seed.

In incubators, chicks are often hatched out in nineteen days. On the contrary, I have had hens which had allowed the eggs to get cold several times through indifferent sitting, hatch chicks on the twenty-third day. Such chicks, however, are rarely of much use. Occasionally eggs have been known to hatch as early as the seventeenth day; but the reason is probably that, in such cases, the perfect egg had been held, from fright or other cause, in the oviduct of the hen for several days after it ought, under ordinary circumstances, to have been laid. As there is nothing as far as is known to prevent the germ from commencing to develop by the warmth and air of the oviduct, an egg laid under such conditions would certainly have the advantage of so many days' start. With ordinary eggs, however, if in an incubator the chicks hatch in less than twenty-one days, it may be inferred that the heat has been more or less too high, and *vice versâ.*

Germination may commence and proceed slowly for a time at even so low a temperature as about 80deg., and development may be retarded by frequent cooling or too low a temperature, through careless sitting, as to cause the eggs to hatch on the twenty-third or even the twenty-fourth day, but it is obvious that if the vitality of the germ is once arrested, its life finally ceases.

Hatching-Time.—A day or two before the hatch is due, take off the hen, and thoroughly dust her and the nest-box with insect-powder or powdered brimstone. This should kill the vermin, and thereby evade the misfortune of the chicks starting life handicapped with a swarm of parasites. After dusting, the hen should be left undisturbed for the last day or two. It is a mistake to carry the chicks away as they are hatched; because, if the hen is comfortably situated, she is fully competent to complete her own business, and probably more chicks are lost than saved by this over-zealous interference.

Hens do not sit so well when surrounded by the chicks of other broods. Their chirping, especially as the period of hatching approaches, seems to unsettle her, and make her restless for chicks of her own. When the chicks are hatched they are therefore better removed at once to be reared elsewhere. To remove a broody hen from its nest, place the hand gently under the breast, not under the wings, as is often done, and in raising her be careful to see that no eggs are enclosed amongst the feathers.

CHAPTER III.

ARTIFICIAL INCUBATION.

Artificial incubation is no new thing. It was practised by the Chinese and Egyptians thousands of years ago, but it is only of late years that thought and invention have succeded in producing a machine of commercial utility in a variable climate like ours, or one that would be more than a useless but fascinating toy, or that would with some degree of certainty produce satisfactory results.

It does not seem a difficult thing at first sight to copy Nature, and by so doing make an incubator to do the work of the hen. It has, however, taken many years and a long series of inventions, trials, and disappointments, to reach the present degree of success, and much has yet to be done before perfection is attained. We still fail in some minute particular to copy Nature exactly; but in what that particular consists, remains to be discovered. There are, however, some machines in the market, which, if pitted, with a given number of eggs, against the uncertainties, risks, and vagaries of hens, sitting on an equal number, would in all probability come out of the trial with the higher percentage of chicks.

ITS ADVANTAGES.

Chicks at Any Time.—The great advantage of an incubator is that it is always ready "to sit," whether early in the season, or in the depth of winter, when broody hens are an impossibility. Chicks may thus be hatched, and with suitable appliances reared, at any season of the year.

Early Chicken Shows.—To those who wish for birds hatched early in the new year, in order that they may have as long a time as possible in which to grow before the early chicken shows, incubators are a necessity; in fact, without such appliances breeders would have little chance.

Early Table Birds.—The same remark applies to those breeders for table who would have fat chickens when the highest prices are obtainable, that is, before the later, naturally-hatched chickens, become plentiful.

Winter Layers.—It is well known that to secure a plentiful supply of eggs in the autumn and winter, when eggs are dear, the chicks should be hatched in March and April. It is often difficult, if broody hens are entirely depended upon, to get as many pullets hatched in these two months as one might desire, because, as a rule, sitting hens are by no means too plentiful in February and March.

Incubators more Profitable. — With an incubator, non-sitting varieties of fowls may be kept with more profit, as hens which have no part of their time occupied with maternal duties lay more eggs. An incubator for fifty eggs does the work of four hens at one time, and as it is prepared for its duties every month of the year without cessation, it is thus equal to about fifty hens.

Incubators less Trouble.—The incubators of former days required much and frequent attention, now they are so perfected in every detail that very little time and attention are needed; in fact, a maximum of results can be obtained with a minimum of trouble.

Eggs Spoilt by Hens.—Often hens are not sufficiently careful to cover all their eggs; sometimes several are left exposed, in which incubation is checked or the embryo killed outright. If it were always the same egg or eggs which were left exposed it would not be so serious a matter as it is; but as the hen re-arranges the eggs daily, the whole sitting during the three weeks may thus in turn be spoilt, especially in cold weather. The loss from this cause, together with eggs often broken by the hen, and the chicks crushed to death at hatching-time, is obviated by the use of an incubator.

Vermin on Chicks.—Incubator-hatched chicks are free from insect pests, which sap the life-blood of many of those hatched under hens.

Rearing.—As regards the rearing of artificially-hatched chicks, little need be said in its favour. This is not at all a difficult matter. Even when hatched by natural means, many prefer to rear their chickens in foster-mothers. I have tried the experiment on several occasions of dividing a batch of artificially-hatched chicks into equal portions, rearing one-half by hens and the other in an artificial rearer. The feeding and treatment generally have been as much alike as possible, and my opinion is that by the latter method the chicks grow faster and do better, with less loss, especially in cold weather.

The foster-mother is always ready with different degrees of heat to suit the chicks. With the hen it is no uncommon thing to hear some of the weaker ones chirping to be brooded, while others have no such desire. Chicks often suffer by being led into damp grass, or too long distances, by their mother, who regulates her pace to a great extent by the stronger ones, and if the hen is cooped up the former often get trampled to death. Artificially-reared chicks thrive better, mature more quickly, are more independent, less timid, and look out better for themselves, because, in addition to advantages already named, they start life free from insect pests which sap the life-blood of many of those hatched under hens, and being kept generally under better protection in movable runs they are less liable to accident, the raids of vermin, and disease. They can be fed more regularly, more evenly, and more economically, as there are no mother or older fowls to devour greedily the more expensive food on which it may be advisable to feed the chicks.

The Small Poultry-Keeper.—In the case of a small poultry-fancier who keeps, say, only about a dozen hens, an incubator, from a purely financial standpoint may not be of any great advantage, unless non-sitters are entirely kept. Where many fowls are kept, a good incubator is a profitable investment; but of course each will determine for himself whether the circumstances of his case warrant such an outlay.

CHAPTER IV.

STRUCTURE AND DEVELOPMENT OF AN EGG.

Shell.—The shell of a hen's egg consists of carbonate of lime, the same substance as that of which old mortar, chalk, &c., is composed, but in a different state. The particles of carbonate of lime forming the shell are arranged in a similar manner to that in which the stones or bricks of an arch are laid by the builder. This gives to the shell the greatest possible strength to withstand pressure from the outside. Between the carbonate of lime are innumerable minute holes, or pores, to admit a limited amount of fresh air to the egg, and also to permit the moisture to escape during incubation. If, however, the smallest pin-hole be pricked in the shell, it effectually prevents the embryo chick from hatching. Again, if the shell is covered with a coat of varnish or other impervious substance, thus closing the pores, this also is fatal to its chances of producing a chicken, for the obvious reason that no germ of life can develop without a supply of oxygen. As the strength of the shell of an egg in its ordinary state would present an almost insuperable difficulty in the way of a chick extricating itself, Nature has provided its own remedy. By the heat of the hen's body or incubator, the particles of carbonate of lime forming the shell undergo an important physical change. They become blended and confused, and lose their regularity and strength of arrangement, thus making the shell brittle, and consequently easy to break. This alteration in the aggregation of the particles accounts for the cracked, brittle sound which may have been noticed when turning eggs in an advanced stage of incubation in an incubator.

Air-Chamber.—Just within the shell, and enclosing the white of the egg, are two delicate porous membranes. At the broader end of the egg, there is a small open air-space, or air-chamber, formed by the separation of these two membranes. This air-vesicle in a fresh egg is somewhat smaller than a threepenny piece; but by the evaporation of its moisture, and the admission of air to take its place, it increases in size with the age of the egg, occupying, in a very stale egg almost one-third of its space. The degree of freshness or otherwise of an egg can therefore, to a limited extent, be tested by the size of this air-chamber.

White of Egg.—The white of the egg is composed of almost pure albumen, a viscous, transparent, and highly-nutritious substance, out of which the chick grows. This albumen is arranged round the yolk in layers of gradually-increasing density towards the centre.

The Yolk.—Inside the white is the yolk, the most nutritious part, composed also of albumen, with iron as the chief colouring matter. The yolk is enclosed in a fine membrane to prevent its admixture with the white. It supplies the nourishment needed by the developing chick and its food for the first day or so after hatching, as the remainder of the yolk is absorbed into the abdomen before it leaves the shell. The yolk is not a disorganised mass as may be supposed from its appearance, but is disposed in layers similar to the white with a small central cavity. These layers can be seen in a hard-boiled egg.

The Germ.—Floating in the yolk and attached to the outside edge of it, a small dark speck may sometimes be seen when an egg is broken into a saucer. This speck is the germ, or embryo, of the future chick, which, owing to an admirable provision of nature, always floats on the top of the yolk, thus keeping as near as possible to the body of the sitting hen. This is effected by the yolk being denser and therefore heavier on the side opposite the germ. No matter into what position the egg may be turned, the centre of gravity of the yolk being always on the opposite side from the speck, the latter comes to the top.

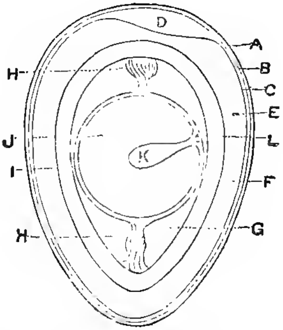


FIG. 1. SECTION OF AN UNINCUBATED EGG.

A, the shell; B C, the double membrane attached to the shell, and separating at the large end of the shell to form D, the air space; E F G, the white or albuminous part of the egg, in three layers of increasing density towards the centre; H H, the chalazæ which hold the yolk suspended in the middle of the egg; I, the membrane surrounding the yolk, to which the chalazæ are attached; J, the yolk, consisting of several layers; K, the central cavity, or utricle; L, the germ.

Fig. 1 illustrates a section of an unincubated hen's egg.

DEVELOPMENT OF THE EMBRYO.

When an egg has been sat upon for a short time, the speck enlarges by the development of minute vessels, which gradually encircle the germ, and extend until they surround the yolk. From the germ a tube proceeds to the centre of the yolk. During the growth of the embryo a series of chemical and physical changes take place. Blood-vessels about the third day appear in the membrane which lines the shell of the egg, and this, being porous, admits the air necessary to aërate the blood. The air-vesicle at the larger end of the egg becomes larger by the evaporation of the water from the albumen through the pores, and the influx of air to take its place (Figs. 2 and 3). The chick, until about fully developed, is encased in a membrane; this, about the nineteenth day, is broken

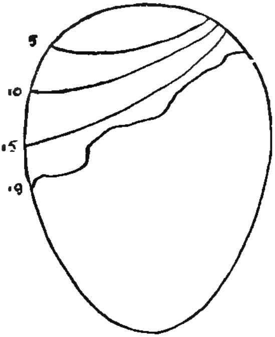


FIG. 2. APPROXIMATE SIZE OF AIR-CELLS OF HEN'S EGGS ON THE DAYS OF INCUBATION INDICATED BY THE NUMBERS.

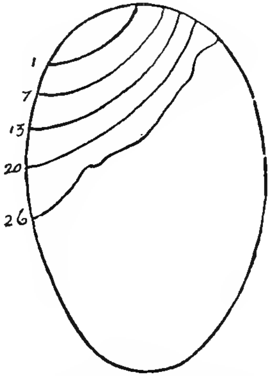


FIG. 3. APPROXIMATE SIZE OF AIR-CELLS OF DUCK'S EGGS ON THE DAYS OF INCUBATION INDICATED BY THE NUMBERS

by the beak of the chick, which then begins to use its lungs by breathing the air in the now much-enlarged air-chamber. At this stage the chick occupies its smallest space in the egg, the air-vesicle alluded to occupying about one-third of the interior. When this vesicle is broken, the chick commences its struggles for liberty, and by its muscular efforts gradually works itself up till it fills the whole space. This gives it greater freedom, and enables it more easily to extricate itself.

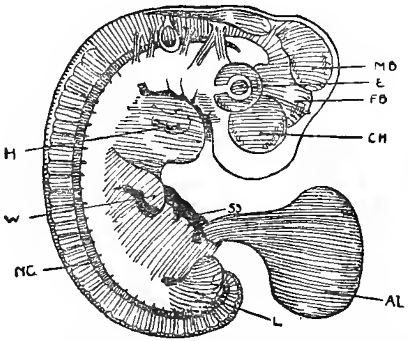


Fig. 4. Embryo at the end of the Fourth Day of Incubation. (Magnified.)

When the chick begins to use its lungs, a peculiar so-called "tapping" sound is heard. This is not, as is sometimes supposed, caused by the tapping (hence the word) of the beak upon the shell in the chick's endeavour to break its way out, but by the expiration of the breath from the lungs. "Tapping" is not a very suitable term to describe the sound, which is similar to what is produced by gently puffing very small quantities of air through almost closed lips as in smoking.

On placing the egg to the ear, other sounds may be heard at intervals—namely, the struggling efforts of the chick to gain more space, which occur several times a minute, dependent upon the vigour of the chick; and also those of the strokes made by the beak of the chick on the shell, which occur at unequal intervals of from one to five minutes.

Fig. 4 shows the embryo (enlarged ten times) at the end of the fourth day of incubation. The cut end of the somatic stalk (by which the yolk is connected with the embryo) is shown at SS with the alantois (AL) coming from it. AL is the alantois, a continuation of the alimentary canal (or rudimentary digestive organs) which gradually enlarges till it completely encloses the embryo, yolk, and albumen or white, and lies close to the shell; CH, the cerebral hemisphere; FB, the fore-brain; E, the eye; MB, the mid-brain; H, the heart; W, the wing; NC, the natochord (rudimentary backbone); L, the leg.

HATCHING OF THE CHICK.

Chipping.—The "chipping," or "spretching," of the shell is the first small star-like fracture. The chick gradually works itself round in the shell, at the same time cutting off the upper portion in the form of a lid. For the purpose of assisting the chick to break its shell, its beak is supplied, just above the point, with a small, hard, horny scale. Owing to the position of the head and beak, this scale comes in direct contact with the shell.

Time in Hatching.—The time occupied by the chick in freeing itself from the shell, varies very considerably, taking from one to twenty-four hours, or even more, according to the strength of the individual, and the thickness of the shell and membrane of different eggs. From three to twelve hours is the usual time. Some chicks work almost continuously for their deliverance, others only at intervals. Before a chick is ready to leave the shell it should have absorbed into the abdomen all the remaining unconsumed yolk, which constitutes its food for about twenty-four hours. It sometimes occurs that chicks leave the shell before this has been done: such are sure to droop and die.

Assistance at Hatching.—After vainly struggling for say eighteen hours, chicks may sometimes be successfully helped out by careful handling; but in doing this should blood appear, desist immediately, as the chick is not ready. My experience, however, is that such chicks are rarely worth the trouble involved, because if they survive the operation they generally succumb soon after.

Chicks Dead in Shell.—Chicks may die from sheer want of stamina or constitution—either hereditary, or brought on by semi-suffocation by the injurious odours of a badly-ventilated machine and other causes—at any stage of development, and the disappointment so often experienced of having a considerable proportion of fully-developed and apparently healthy chicks dead in shell at hatching-time, is undoubtedly owing to the extra physical exertion necessary at this time to free themselves from the shell.

Just before leaving the shell the chick draws its head from under its wing, where it had till now been folded, stretches out its neck, and lies for a time apparently exhausted. After a few more struggles its deliverance is complete.

The Downy Feathers.—Being wet with the fluid of the egg, the chick has the appearance of being naked. The downy feathers with which its body is covered possess innumerable minute branchlets, enclosed in delicate membranous tubes. As the chick dries, the tubes split, the branchlets or beards become disentangled, and spread out by their own elasticity, enveloping the chick with its covering of soft down.

Cripples.—This may be a suitable place in which to allude to the causes of crippled chickens which are often met with. It is the generally accepted opinion that the causes are unexpected, sudden noises, great variations in temperature, and lack of moisture, contributing to such condition. A continuous sound, such as the noise of traffic in the streets, though not a desirable condition, seems to produce no seriously ill effects, whereas the same sounds at intervals probably would.

CHAPTER V.

PRESERVATION OF EGGS.

From the description of the construction of the egg already given, it will be seen that the objects to be aimed at in preserving eggs for incubation or other purposes are to keep the germ from being injured by adhering to the shell, and the egg from losing its moisture. Frost or heat must be carefully avoided, as half-an-hour's exposure to either is sufficient to kill the germ. A temperature of 80 or 90deg. for any length of time would cause germination to begin, and this, if afterwards checked, would be fatal to the embryo. The best place in which to keep eggs for incubation is a dark, cool, damp cellar (temperature the nearer 45deg. the better); but there is a difference of opinion as to whether it is better to store them with the large end upwards or downwards. Undoubtedly to turn them over daily would be much better than either. When the large end is uppermost, the air-space prevents the germ from coming in contact with the shell, thereby removing the danger of its adhering to it. On the contrary, when the large end is downwards the weight of the contents of the egg presses on the air-chamber, and perhaps, to a certain extent prevents its enlargement.

Selecting Eggs for Incubation.—Choose for incubation eggs of average size and good shape only, and the fresher the better. Stale eggs always hatch later than fresh, and if very stale, probably not at all. A fortnight is the longest period to keep eggs for this purpose, unless very valuable, and when possible they should not be over a week old. The strength of the germ deteriorates with age, and an embryo may die in the shell before incubation commences, just as it may do at any later stage.

THE ESSENTIAL FEATURES OF AN INCUBATOR.

To produce a healthy chick from a fresh egg, heat, air, and moisture only, in proper proportions, are needed.

Heat.—We will consider the various essential features of a good incubator. The best heat at which to work an incubator for hens' eggs is as near as possible 104deg. If the bulb of a thermometer be placed under a sitting hen, the heat registered will deviate very little from this. Some people are of opinion that the best results are obtained if the heat at which the incubator is worked is varied according to the temperature of the room in which it is placed. Taking 104deg. as the mean when the room registers 60deg., it is recommended to lower the heat inside the incubator, as the temperature outside increases, and *vice versâ*. Thus, if the normal temperature of the room is 40, 50, 60, 70, or 80deg., the incubator should be adjusted to work at 106, 105, 104, 103, or 102deg. respectively. The most favourable temperature, however, for an incubator-room, is from 55 to 65deg.

As it would be fatal to have the eggs at one time at 95 and at another time at 110deg., there are several methods of regulating the supply of heat in order that the temperature of the egg-chamber may keep regular, regardless of size or quantity of the heat supply, or the temperature of the outside atmosphere. A description of several of these heat-regulators will be given later.

Position of the Heat.—The heat must be above, or, in other words, descend to the eggs as the embryo chick floats near the top of the egg.

Position of Thermometer.—Level with the top of the eggs is the position in which the bulb of the thermometer should be placed to register the heat of the chamber, as an inch or two above the eggs is always several degrees higher, and under the eggs many degrees lower, than the heat in the correct position. Many hatches have been ruined by amateurs, in their own-made machines, placing the thermometer too high, with the result that it has registered 104deg. all right, while the eggs have been at, say 101 or 102deg.

Quantity of Artificial Heat Required.—The quantity of artificial heat required to keep the egg-chamber at the proper degree varies with the heat of the room in which the incubator is placed, and with the stage of incubation reached by the eggs. It is obvious that if the normal temperature of the room stood throughout the three weeks' period as high as 104deg., no artificial heat at all would be required. The lower the heat of the room, the greater is the deficit of heat to be supplied artificially to keep the egg-chamber at 104deg.

Natural Heat.—In the earlier stages of incubation, the eggs require a greater supply of artificial heat than in the later. About the tenth to the fourteenth day in its development, the chick commences to generate a natural heat in the shell, which assisting the artificial supply, the latter may be decreased to an equivalent extent.

With a thermostatic regulator, of course the circumstances just mentioned do not affect the unvarying temperature which ought to be maintained in the egg-chamber, as the surplus heat is caused automatically to escape; but this surplus represents so much waste, as much as possible of which it is advisable to save.

Methods of Supplying the Heat.—There are two methods of supplying the heat: either by radiation from a hot-water tank, or hot-metal plate or pipes, or by the hot fumes of the lamp going straight into the chamber. The latter method is now quite discarded in good incubators, as the carbonic acid gas from the lamp is as injurious to the developing chick as it would be to human beings.

Distribution of Heat.—The heat should be pure, hot air, and evenly distributed over every egg. This is a fault in some incubators, the heat varying several degrees in different parts, the centre being, as a rule, the highest, and round the outside the lowest.

Getting Rid of Surplus Heat.—The incubator maintains its regular heat by getting rid of whatever excess is produced by the flame in one of two ways: either by raising a damper from the lamp-flue, and allowing the surplus to escape without entering the machine; or by raising a ventilator in the top of the incubator and allowing a portion of the hot air already in the machine to escape, an equivalent amount of cold air entering from beneath to supply its place, and by so doing reduces the temperature to the proper degree. The former plan is decidedly preferable. The poor success or failure of some incubators, although successful in maintaining a fairly regular heat, may be attributed to the chill given to the heated eggs by this continual influx of cold air.

Draughts.—Draughts, or currents of cold air, are fatal to the delicate organisation of the egg, and no incubator in which the heat is kept regular by the disposal of its hot air by ventilation can produce equally satisfactory results to one in which the surplus heat is not allowed to enter the machine at all.

Ventilation.—This brings us to the question of the amount of ventilation needed. During the development of the embryo, and especially during the decay of a dead germ, certain injurious gases are generated, which must be allowed to escape. It was also made clear, when dealing with the "Development of the Embryo," that fresh air is essential, but with regard to the amount of fresh air necessary, there is some difference of opinion. Under a sitting hen the eggs do not get much, and in an incubator no more is needed than is sufficient to slowly and imperceptibly replace the air without the slightest approach to a current.

Moisture.—Not only must the hot-air be regular in degree, and pure, but it must be moist. Dry air, by absorbing the moisture from the albumen and hardening the membrane of the egg, would render it an almost physical impossibility for the chick to extricate itself from the shell, even supposing it should be fortunate enough to live to reach that stage. A sufficient degree of humidity to prevent this abstraction of moisture is desirable, but not more. Air is capable of holding a certain quantity of moisture in solution, which varies with the temperature. When the temperature is constant, the amount of vapour will be the same, if the air is charged to the extent of its capacity. Beyond this, if any further addition were made, the surplus would become condensed in the form of steam. This would be injurious, as a portion of it would be yielded up to the eggs. (See also p. 29.)

Position of Moisture-Supply.—Although the heat must be above the eggs, it is immaterial whether the supply of moisture comes from above or below. The eggs of a hen, sitting in a natural state, receive moisture from the ground and also from her wet feathers after her daily journeys through damp grass.

In some incubators the fresh air enters the chamber above the eggs. It descends gradually to the eggs, and is drawn out below through one or more exits, or merely diffuses out through a porous incubator bottom, being forced downward by the pressure of the incoming heated air above. It is easy to see that by this method the passage of air through the incubator is less rapid, and there are no perceptible currents; but, on the other hand, there is greater danger of the purity of the air being impaired by a too sluggish change of air.

If a water-tray is placed above the eggs—though in the type of so-called non-moisture incubator under consideration this is not generally considered necessary except under special conditions—the incoming air may become charged with moisture to saturation at a high temperature at the top of the incubator, and, as it descends and cools, its moisture capacity is diminished, and its moisture becomes condensed into a visible form which would be as deleterious as too great a dryness, for the eggs would be prevented from giving off the moisture necessary during the development of the chick.

As the incoming air will vary in humidity according to the locality and the weather, and as with these varying conditions the amount of added moisture for best results will also vary, each incubator user should, if possible, find out for himself by experiment, how much moisture to add according to his circumstances and the season, in order to charge the air with a degree of humidity a little short of the amount that would cause condensation. The amount of evaporation at a given temperature depends upon the *area* of the *surface* of water exposed, and not upon its volume or depth. For instance, a tray six inches square (thirty-six square inches) will give off twice as much vapour as one six inches by three inches (eighteen square inches), irrespective of the depth of either.

CHAPTER VI.

MOISTURE IN INCUBATORS.

THE egg contains all the water necessary for the chick's development, and the object in surrounding the eggs with a humid atmosphere is to prevent its dissipation by undue evaporation. Another highly-important function performed by moisture is that of absorbing the liberated carbonic acid. At ordinary temperatures water will absorb its own volume of this gas. In summer more moisture is found to be advisable in incubators than in winter, and this is sometimes erroneously attributed to the supposed greater dryness of the air, whereas the atmosphere in summer generally contains much more moisture than in winter. By way of illustration, suppose the temperature of the summer air to be 70deg., having a moisture capacity of, say, 10. Entering the incubator, this air is raised to 104deg., capable of containing, say, 20deg. of moisture. Its drying capacity may, therefore, be represented by the difference between 10 and 20—that is, by 10. Now take the air of winter at a temperature of 35deg., with a capacity for holding vapour of, say, only 1deg. This air is also raised in the incubator to 104deg., with an absorbent capacity of 20, as before. Its drying effect would thus be 19, or nearly twice as dry as the summer air. It is evident, therefore, that the extra artificial moisture required in summer, which is proved by experience to be beneficial, is not necessitated by the dryness of the warmer air. The probable cause is that, in summer, on account of the greater sluggishness with which the air is changed in the incubator, or of the comparative slowness of ventilation, owing to the density of the outer air approaching more nearly that of the inner air, the carbonic acid (or, more strictly, carbonic anhydride), not being carried away as quickly, accumulates more rapidly, and requires more water to absorb it, and to free the air of its narcotic effect.

The different aspects of the subject of fresh air and moisture may be thus summarised:

(1) In summer the passage of air through the incubator, with a given amount of outlet, is more sluggish than in winter, and the percentage of carbonic acid in the egg chamber increases, which, as shown elsewhere, is indirectly injurious in proportion to the amount of oxygen it displaces. As the development of the embryo depends upon its supply of oxygen from without (moisture and every other element required existing within the egg), any curtailment of this vitalising element will check or retard it. In other words, the rate at which the chemical and physical changes in the egg take place, is regulated, within limits, by the amount of oxygen (and warmth) supplied. If development is too slow, owing to sluggish ventilation, the size of the air cell will be, at a given stage, too small, as normally the embryo contracts in the shell at a uniform rate till about the day before hatching. By adding artificial moisture, the carbonic acid is absorbed, oxygen takes its place, the growth of the chick is accelerated, and the air cell enlarges.

(2) But, it will be said, as the ventilation is decreased, the humidity of the egg-chamber is increased, inasmuch as the more rapid the air current the more drying is it in its effect, and this extra humidity should, by absorbing the carbonic acid,

make up for the slower exchange of air. A little consideration, however, will show that the extra humidity, resulting from slow ventilation, is got by the moisture lingering longer in the machine, and becoming gradually charged with carbonic acid. The sluggish ventilation, although allowing the moisture saturated with carbonic acid to *dwell* in the incubator, does not permit it to *leave* the machine quickly enough. By adding artificial moisture, more carbonic acid is absorbed and carried out, and the air is made purer, but at the risk of rendering the air so damp that the egg cannot eliminate its moisture during its development, and may even absorb some, thereby causing the chick to occupy too much space in the shell, as shown by too small an air cell. The remedy, therefore, in this case, is to increase the ventilation, which, briefly stated, acts thus: More fresh air, quicker outflow of carbonic acid, and replacement by oxygen, egg-chamber prevented from becoming too humid, structural growth of chick quickened, and air-cell enlarged. The increased air-current, being warm, will not chill the eggs.

(3) In winter less artificial moisture is needed, because, owing to the density of the outer air, the inner air is changed, the carbonic acid is carried away and replaced by oxygen more rapidly (for the same reason that a fire burns more brightly in cold weather than in warm), the development of the embryo is hastened, and the air-cell enlarged.

Care must be taken not to confuse the growth of the structures of the chick—which proceeds at a rate dependent entirely, within reasonable limits, on the warmth to which it is subjected (outside moisture not affecting it)—with the space the embryo occupies in the shell. For instance, take two equally-well fertilised eggs on, say, the fifteenth day of incubation, both having been subjected to the same temperature of 103deg., but one egg having been all the time surrounded by vapour-saturated air, and the other by dry air. The structural development of both embryos would be probably about the same, but in the former case the chick would, owing to the more watery nature of the yolk, organs and tissues, be much larger, and the air-cell much smaller, than in the latter case. Probably neither chick would hatch out, as the deleterious effects of too much moisture in one case and too much dryness in the other, would prove fatal, the fact becoming apparent only at hatching time by the chick being "dead in shell."

About the seventeenth or eighteenth day of incubation the membranous covering of the chick is broken. The inmate, thereby gaining better access to the outer air, commences gradually to use its lungs, the circulation within the lining membrane becomes at the same time more and more sluggish, and ultimately dries up just previously to the chick's exit. While too much evaporation of the egg's moisture is generally fatal, the use of too much artificial moisture, on the contrary, by unduly prolonging the drying-up of the vessels in the lining membrane, after the commencement of the pulmonary circulation, may so interfere with the vital functions as to cause death. Through the presence of too much vapour, some is absorbed, and the membranous blood-vessels are kept fluid and active after they should, under proper conditions, have ceased to act.

If the heat of the incubator remains constant, structural development will, on the average, proceed at the proper rate, the air-cells increasing in size at a corresponding rate. The size of the latter, therefore, shows whether too much or too little moisture is being used, as either is deleterious. A little allowance, however, must be made for the fact that the air-cells of old and thin-shelled eggs are somewhat larger than those of perfectly fresh and brown, thick-shelled eggs. As the amount of moisture or the drying power of the air depends largely on the ventilation, the moisture supply can be regulated either by adding or withdrawing artificial moisture, or, to a limited extent, by lessening or increasing the ventilating outlets.

In natural incubation the eggs are not dependent upon any outside supplies of moisture to obviate the danger of undue evaporation, as they hatch equally well in reasonable dry or damp locations, or in any of the varying degrees of atmospheric humidity; but in artificial incubation the case is different. If half-a-dozen eggs containing live chicks within about a day of hatching be taken from under a sitting hen, and half-a-dozen similar eggs be taken from an incubator, and both placed in warm water, it will be noticed that small bubbles will immediately form on the submerged portions of the incubator eggs, and as these bubbles rise to the surface, the eggs will sink, whereas on the naturally-incubated eggs no such bubbles will form.

This difference in behaviour is easily explained. The latter eggs become coated with an oily secretion, giving them a glazed appearance, which, penetrable sufficiently to air, renders eggs much less porous, and so checks the diffusion of moisture through the shell, either inward, when the outer air is too damp, or outward when the outer air is too dry. The incubator eggs have not this oily protection, and, being more porous, the water enters, pushes out the bubbles of air, and the chick is drowned in the shell.

If it were possible to find a hen that could sit three weeks on its eggs without giving them this oily coating—that is, if it were possible to keep them in the same porous condition as incubator eggs, it is probable that very indifferent success would be the result, as the eggs would be far more at the mercy of the humidity of the location of the nest, and of the atmosphere, than is the case in nature. As we do not know how the natural method of checking evaporation could be applied to artificial incubation, the only means we have of effecting the same purpose is by charging the air with moisture sufficiently to deprive it of its tendency to absorb more. In hot water tank incubators, with bottom-to-top or upward ventilation, this is done by causing the incoming fresh air to pass over moisture trays. In the non-moisture (so-called) hot-air incubators with descending ventilation, the moisture eliminated from the eggs during incubation is retained in the egg-chamber by the higher absorptive capacity of the heated air. As the air descends and cools, its moisture-holding capacity is reduced, its moisture being left behind in the more highly-heated air.

As we have before stated when dealing with natural incubation, as the heated air leaves the nest it parts with much of its heat and moisture to the incoming cool air, thus carrying away a minimum amount of vapour—only as much, in fact, as keeps pace with the amount thrown off by the eggs and the body of the sitter, the air in the nest being always, therefore, slightly moister than the outer air. In some incubators on the market a fairly practical and successful attempt has been made to copy Nature in this respect, and a degree of humidity a little in excess of the outer air is maintained.

CHAPTER VII.

HOW TO USE AN INCUBATOR.

Best Position.—The best place for an incubator is a quiet room, of equable temperature, and free from draughts. Any outbuilding (not of glass or iron), a bedroom, or well-ventilated cellar, are suitable places. Many people think—and, from experience, I am of the same opinion—that the eggs hatch out better if the incubator stands on a stone floor probably owing to its comparative freedom from vibration.

Adjustment of Regulator.—Adjust the regulator to work at 104deg., or as under: When the room stands at 40, 50, 60, 70, or 80deg., the regulator should be adjusted to keep the machine at 106. 105, 104, 103, or 102deg. respectively. The best temperature for the room is between 55 and 65deg., as then less strain is put upon the regulator.

Turning the Eggs.—The eggs should be turned at least once a day, though twice is safer. This is not, as is sometimes supposed, to warm the egg all round. During the earlier stages of incubation the embryo, which is attached to and floats on the top of the yolk, presses against the inside of the shell, and if allowed to remain long in one position, the albumen surrounding the yolk is gradually forced aside; the heat dries the thinned stratum of albumen left, and the germ becomes glued to the shell. The drier the air, the quicker does this adhesion take place. The extreme care taken by some to ensure that the eggs are turned quite over each time is unnecessary. All that is needed is a movement of the eggs to prevent the germs from remaining too long in one position. A mere shuffle over, if done twice in a day, is sufficient.

Cooling the Eggs.—When the eggs are turned, they are better allowed to cool at least once a day for five minutes in winter, and ten minutes in summer. Some incubator users ignore the expediency of this. I have tried hatches which have been allowed a reasonable time for cooling daily, and hatches in which the incubator was never open longer than was absolutely necessary to turn the eggs, and my experience is that the eggs do better, and hatch out stronger chicks with a daily cooling. The reason is, probably, that by the cooling and consequent contracting of the air in the air-chamber, the egg absorbs an extra supply of oxygen.

Cold Eggs in Incubator.—Cold eggs, when placed in the incubator along with others already advanced in incubation, should be separated by a partition of cardboard or wood, to prevent their giving the warm eggs a chill; or the cold eggs may be warmed by washing in water heated to about 80deg., afterwards drying them well before putting in. The reading of the thermometer should not be relied upon as a correct indication of the general heat of the incubator till the eggs are warmed through.

Spraying the Eggs.—The water-trays should he daily replenished with warm water. It is also well, about two days before hatching, to lightly spray the eggs with tepid water; but after doing so the egg-drawer should be replaced in the incubator immediately.

Hatching-Time.—Do not open the incubator when the eggs are chipping oftener than is necessary; but when it can be done without opening the machine purposely, turn the chipped side upwards.

Thermometer. — Observe the thermometer whenever the incubator is attended to, as a guide to its correct working.

Lamp.—Always keep the lamp well trimmed, and do not burn it higher than is necessary.

Cracked Eggs.—If in testing, &c., you have the misfortune to crack an egg, fix a little gummed postage-stamp paper over the crack, and it will probably hatch all right.

Time of Incubation.—This is as follows: hen, 21 days; duck, 28; goose, 30 or more; turkey, 28; pheasant, 24; partridge, 24; peafowl, 28; swan, 58; ostrich, 42.

Testing a Thermometer.—To test a thermometer, place the bulb in the mouth with the lips closed. If, when the mercury has risen to a stationary point, it is between 97 and 99deg., the thermometer may be considered correct. If it is a straight thermometer, get a friend to read it for you, before removing it from the mouth. Some thermometers have a small expansion-chamber at the top, in which occasionally a little mercury lodges, which is difficult to remove. A globule of mercury, almost invisible to the naked eye, is sufficient to make the reading one or two degrees less than the correct one.

Correcting a Thermometer.—When the mercury has got divided, to correct the same place the bulb in warm water, increasing the heat by the addition of hot water, till the mercury rises into the expansion-chamber. A gentle tap on the top of the thermometer as it cools will probably join the disconnected portions.

Egg-testing.—The object of egg-testing is to detect the unfertile eggs and remove them—for clear eggs are still good

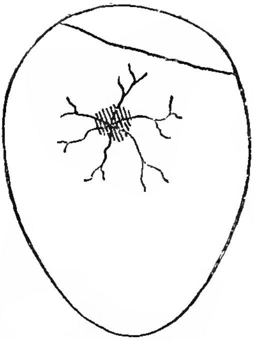


Fig. 5. Fifth Day.

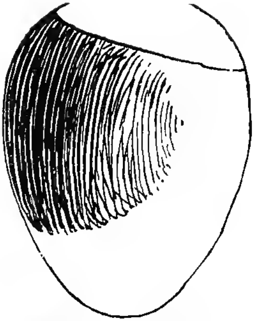


Fig. 6. Tenth Day.

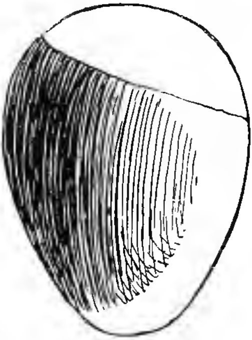


Fig. 7. Fifteenth Day.

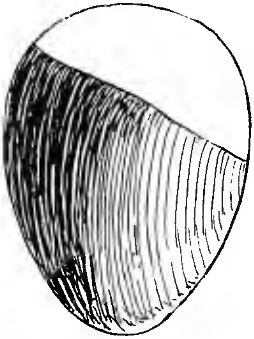


Fig. 8. Eighteenth Day.

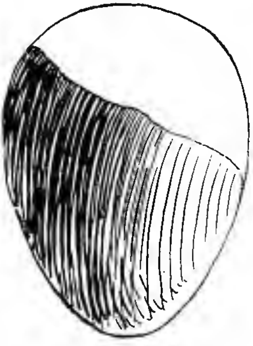


Fig. 9. Nineteenth Day.

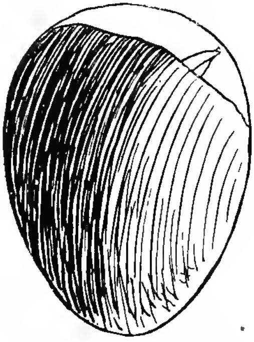


Fig. 10. Twentieth Day.

Figs. 5 to 10. Diagrams showing a Vigorous Embryo as seen through an Egg-Tester on the Days of Incubation indicated.
These Diagrams also show the gradually increasing size of the Air-Cell.

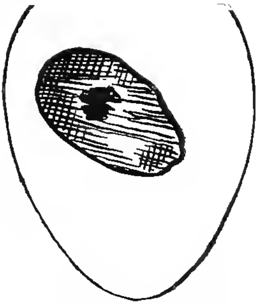


Fig. 11. Fourth Day.

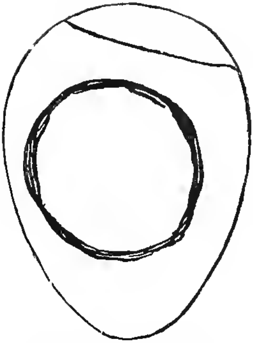


Fig. 12. Seventh Day.

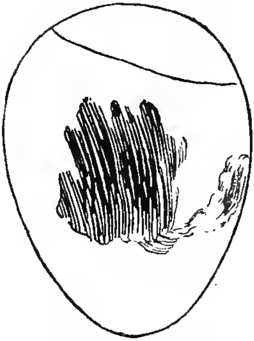


Fig. 13. Eleventh Day.

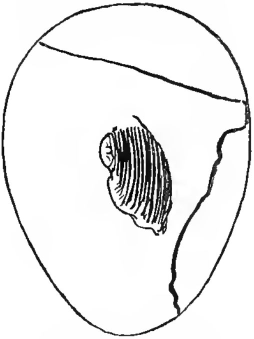


Fig. 14. Thirteenth Day.

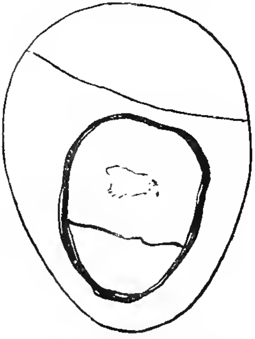


Fig. 15. Sixteenth Day.

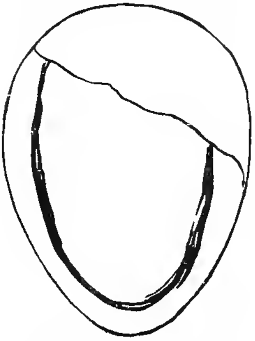


Fig. 16. Nineteenth Day.

Figs. 11 to 16. Diagrams showing Various Forms of Addled Eggs.

The different appearances, as seen through an egg-tester, depend on the stage of incubation at death, or cause of death—whether prolonged over-heating, or under-heating, sudden excessive heat, sudden excessive chill, remaining too long in one position, violent shaking causing broken yolk, or what not.

for culinary purposes; a great saving is thereby effected. In addition, the space occupied by these eggs, useless for incubation purposes, can be filled with eggs of possible hatching value. For instance, if three hens should be set together, and on the first examination it is found that one-third of the eggs are unfertile, the fertile eggs left can be managed by two hens, the third receiving a fresh sitting.

Some people profess to be able to tell whether an egg is fertile or not before setting it, and also, by the shape of the egg, to distinguish its sex; but I think all attempts as yet to determine either have ended in failure.

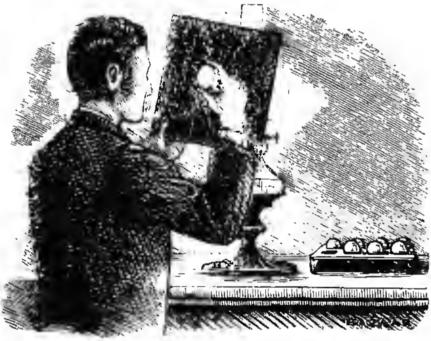


FIG. 17.—TESTING FERTILITY OF EGGS.

Cut a hole about the size and shape of an egg in a piece of cardboard. Hold the egg in front of this hole before a strong light (Fig. 17); no other light should be in the room. In fertile eggs, about the sixth or seventh day, the embryo chick appears as a dark spot in the centre of a number of bright red veins, or, in other words, something like a spider with long legs. The better to see this, it is advisable when lifting the egg from the incubator to examine, to keep the side uppermost in the drawer towards you, as the embryo floating on the top can thus more readily be seen.

Unfertile eggs are quite clear, like fresh ones. Broken yolks have not the dark spot seen in fertile ones, and can be further distinguished by having a blood-vein lying close to the shell. Addled eggs—in other words, fertile eggs in which germination has been arrested and putrefaction set in—have a dark-looking, broken mass in several parts, portions of which adhere to the shell. Addled eggs in which the death and decay of the germ have occurred at an early stage, will probably explode with a loud report on being broken; others, in which incubation has advanced further, will not. All addled eggs should be at once removed from the incubator. Good eggs, if again tested on the fourteenth or fifteenth day, will be found to be opaque.

Figs. 5 to 16 will give a better idea of the appearance of eggs in the various stages, and the development of the chicken in the egg is clearly shown in Figs. 18 to 25.

Brief Points on Managing an Incubator.—Do not waste time on doubtful or unfertile eggs, therefore test them on the seventh day and again about the fourteenth. Do not disturb them after the evening of the eighteenth day. Turn the eggs over every day, and cool them once a day. Before placing in the machine, let the eggs rest a few hours, noticing that the large end is uppermost. Study the incubator, make yourself acquainted with the purposes of all its parts, and follow the manufacturer's instructions in setting up and operating. Do not overfill the egg tray. Get the adjustment of regulator right before putting eggs in, then do not tinker too much with it, but leave it to do its work. Keep the lamp clean and

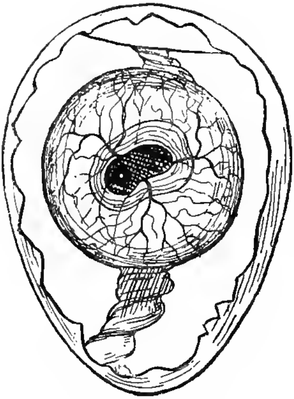


Fig. 18. Fifth Day.

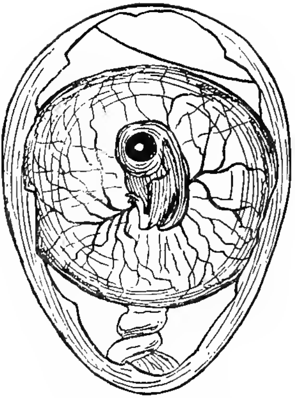


Fig. 19. Eighth Day.

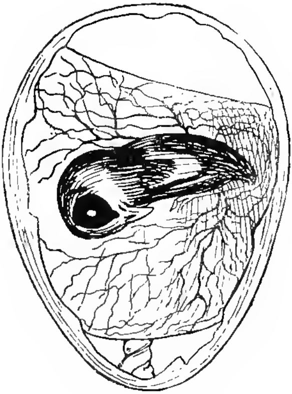


Fig. 20. Eleventh Day.

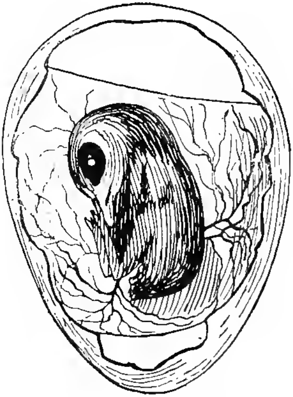


Fig. 21. Thirteenth Day.

Figs. 18 to 21. Diagrams showing the Development of the Chicken in the Egg.

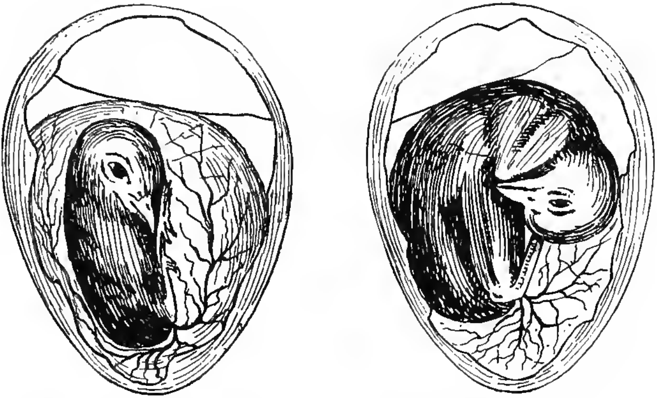


FIG. 22. FIFTEENTH DAY. FIG. 23. SEVENTEENTH DAY.

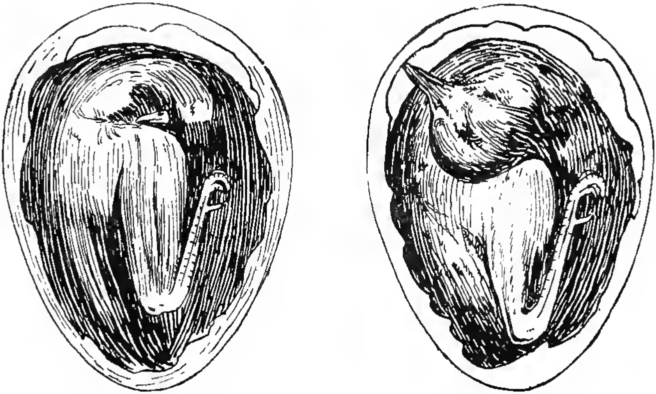


FIG. 24. NINETEENTH DAY. FIG. 25. TWENTIETH DAY.

FIGS. 22 TO 25. DIAGRAMS SHOWING THE DEVELOPMENT OF THE CHICKEN IN THE EGG.

regularly supplied with oil, and thus avoid smoke. Have clean hands when handling the eggs Do not place your machine in a draughty place, or where the sun may shine on it, or near the fire. See that the thermometer is correct, especially that no portion of the mercury is detached, or lodging in the small expansion chamber at the top of some thermometers.

THE PRINCIPLE OF THERMOSTATS.

The chief difficulty makers of incubators have had to overcome has been the maintenance of a uniform temperature in the hatching-chamber in spite of the variations in the temperature of the atmosphere or the fluctuations in the heat-supply.

The object aimed at and accomplished has been to secure a power or force to raise or lower a damper or ventilator, or to raise or lower the heating flame, so as to throw off or retain heat according as the temperature of the egg-chamber is above or below the desired degree.

The force created by the vaporisation or distillation of suitable volatile fluid is utilised for this purpose. All liquids, like water, have a certain fixed boiling-point, which varies considerably. Thus water boils at 212deg. (Fahr.), ether at 95deg., bisulphide of carbon at 118deg., alcohol at 173deg., benzole at 176deg., sulphuric acid at 640deg. When the vapour cools again it will return to its liquid state, and occupy exactly the same space that it did before. The heating and cooling may go on indefinitely, and if the liquid be hermetically sealed the quantity will remain the same. By the mixture of two fluids, methylated spirit (or alcohol) and ether, in the proportions of 3 of ether to 1 of alcohol, a liquid is got that boils a little below 104deg., Fahr.

The Capsule Regulator.—The thermostat most in use in incubators of the present day is the spirit capsule, and consists of two round, or square, discs of thin, pliable brass, soldered together at the edges. These two discs enclose about twenty drops of a fluid similar to that just described. When a sufficient degree of heat is reached, a part of the liquid vaporises, and as this vapour occupies hundreds of times the space it did in its liquid form, the flattened sides of the discs become distended into an ellipsoid form. I will show presently how the expansion of this capsule is utilised to regulate the temperature of the egg-drawer.

The two discs of which both the round and the square capsules consist are, while the capsule is in use, in a state of continued tension owing to pressure from within or without, and must, therefore, be sufficiently thin and ductile to bear these changes, and at the same time be impervious to the volatile spirit within. It often happens that, after working satisfactorily for one or two seasons, a capsule fails, generally owing to the loss of the spirit by leakage. A metal consisting of an alloy of copper is considered the best, it having the tensile qualities of pure copper, and at the same time being more malleable, and consequently capable of being made thinner.

CHAPTER VIII.

INCUBATORS.

Hearson's Champion Incubator (Spratt's Patent Ltd., 24 and 25, Fenchurch Street, London, E.C.).—The general appearance of this incubator is shown in Fig. 26, while Fig. 27 is a section of the incubator from left to right, and shows how it would appear if cut through in a line with the lamp-burner. The upper half of the box contains a tank of water (AA), through

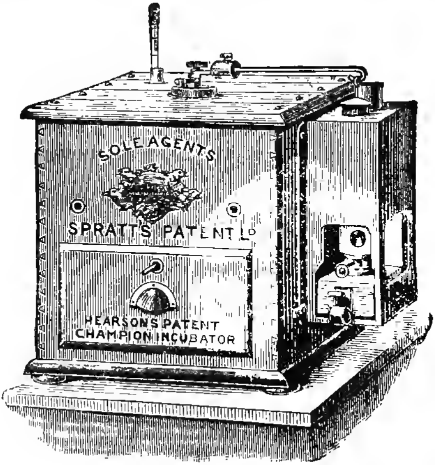


FIG. 26.—HEARSON'S CHAMPION INCUBATOR.

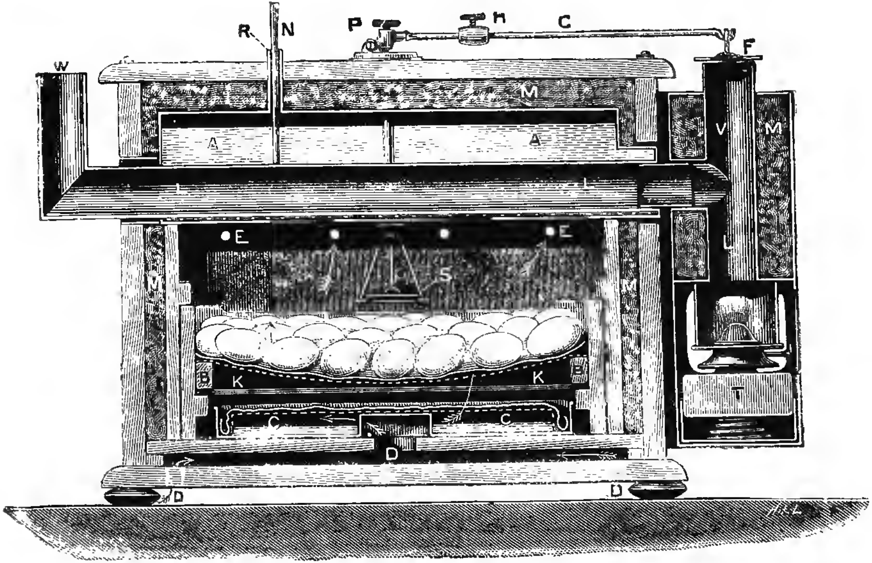


FIG. 27.—DRAWING OF SECTION OF HEARSON'S CHAMPION INCUBATOR, SHOWING THE INTERNAL ARRANGEMENTS.

AA, Tank of Water; BB, Movable Egg-tray; CC, Water-tray; DDD, Holes for Fresh Air; EE, Holes for Ventilation; F, Damper; G, Lever; H, Lead Weight; KK, Slips of Wood; LLL, Lamp-chimney and Flue-pipe; MMM, Non-conducting Material; N, Tank-thermometer; O, Needle for Communicating the Expansion of Capsule (S) to the Lever (G); P, Milled Head-screw; R, Filling Tube; S, Thermostatic Capsule; T, Petroleum-lamp; V, Chimney for Discharge of Surplus Heat; W, Chimney for Discharge of Residual Product of Combustion.

which a pipe or flue (LL) passes from one side to the other. In practice this flue is returned through the water, to still further extend the heating surface and improve the appearance of the apparatus; but I have shown it only carried straight through in the section, to simplify the drawing.

The flue (LL) is turned up at both ends, but at one end the vertical piece of pipe (V) is continued downward to receive the heated products of combustion from a lamp- or gas-flame, which burns directly below the opening.

The upper end of the chimney (V) is furnished with a plate of metal, or damper (F), which—when resting on the top of the chimney—entirely prevents the escape of the heated air in that direction; the consequence is that the whole of it is compelled to pass through the horizontal flue (LL) in the water-tank and up through the chimney (W), most of the heat being parted with on the way. When, however, the damper (F) is considerably raised, the whole of the heated air will escape at the outlet (V), and none of it will go through the horizontal flue in the water-tank.

It will doubtless be perceived that if by any means we can make the changes of temperature in the drawer operate this damper, we shall be able to control the heat of the water by utilising the whole or any part of the heat derivable from the lamp.

The illustration shows the little damper (F) suspended at the end of a light lever (G), the opposite end of which is pivoted to a frame fixed on the top of the wooden case. At a short distance from the pivoted end a piece of stiff wire (O), descends quite through the water-tank, a small tube being provided to protect it, so that the water does not interfere with it. Directly under the end of this in the space above the drawer is a little table, which is fixed at such a distance from the water-tank as will allow the drawer to be removed without disarranging it. On this little table will be observed the metal capsule (S), and it is on the button of this capsule that the lower end of the wire (O) going through the tank rests.

In this way we have established a communication between the capsule in the drawer and the damper. Now let us see how the latter will be affected by changes of temperature in the drawer.

I have already explained how the capsule expands as soon as it gets hot enough to make the enclosed liquid boil, and for the sake of illustration we will suppose that the incubator has been in use, but that we have had the drawer out for a few minutes. Under these conditions the damper (F) will be resting on the chimney (V), because the capsule has been cooled, and has consequently collapsed; but if we put the drawer in its place, the heat will in a short time accumulate, and the liquid will boil. When it does so, the top of the capsule will be distended, and the wire (O) will be moved up a short distance. The motion thus communicated to it will be considerably multiplied by the lever, so that for a slight expansion of the capsule the damper will rise far enough from the chimney to allow the heat from the lamp to escape by that outlet. In practice we seldom find the damper rise more than ⅛in., such rise depending entirely on the excess of heat to be disposed of.

The position of the damper therefore, furnishes a most reliable index of the heat required; for if the damper be found to stand more than ⅛in. above the chimney, we know that we are burning more gas or oil than we need do, and the flame may be lowered until the most economical point is reached.

I have stated that under the normal pressure of the atmosphere liquids boil at fixed temperatures. I must now add, that if we put a pressure on them their boiling is retarded; this is the object of the little weight which slides along the lever. A similar arrangement may be seen on steam boilers, and it is fairly well known that if the weight be moved towards the free end of the lever, the safety-valve is held down more forcibly, and that the pressure and temperature of the steam increase in proportion to the load. Precisely the same action takes place in the capsule, which is a little boiler; and when we load it heavily, we must heat it to a higher temperature before the expansive force of the steam is able to distend its top.

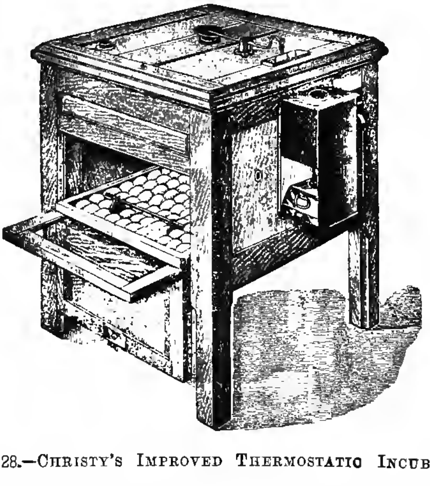


FIG. 28.—CHRISTY'S IMPROVED THERMOSTATIC INCUBATOR.

Christy's Improved Thermostatic Incubator (Edw. Spencer and Co., Mile End Road, Bow, E., consists of an incubating chamber, with a heating-tank of galvanized iron above, and an egg-drawer below, enclosed in a double-walled case with packing between. It is fitted with double doors in front, the inner one glazed to permit of free inspection of the eggs during the process of hatching without chilling the same.

The egg-chamber contains water-trays to supply the necessary moisture, and is supplied with fresh air by tubes through the sides. The pure moist air descends and circulates round and under the eggs, being constantly drawn down through the hole in the false bottom, and thence up between the casings, and out at the top valve (not through a vertical hot-air exhaust shaft, as shown in Fig. 28), this improvement having been introduced since the block was made. The heating-tank is supplied with hot water from a copper boiler attached.

The following description of the details in the sectional drawings (Figs. 29 and 30) will explain the working: A is the air-valve controlling the exhaust air-shaft (L), and is attached to the lever (B), which moves on the centre (C). The lever (B) is connected with the motor by means of the rod (E) and the arm (F). The nut (D) screwed on the rod (E), gives the necessary power of adjustment. As the temperature in the incubating-chamber (Q) rises, the regulating coil expands and pulls down the arm (F), and with it the connecting-rod (E), thus opening the air-valve (A), and at the same time closing the water-valve (G). As the slide-valve (G) descends, it gradually cuts off the circulation of the water from the boiler (K) to the tank (I), until the circulation is entirely confined to the outer tank (H), the lid of which has been opened by the same movement. L is the air-shaft, and M the sliding part of same, which should rest in its socket on the bottom of the egg-tray (T) while the machine is working, but must be pushed up into L to permit the egg-tray to be withdrawn. N is the filling pipe, which can also be used for taking the temperature of the water with a long thermometer. Q is the incubating

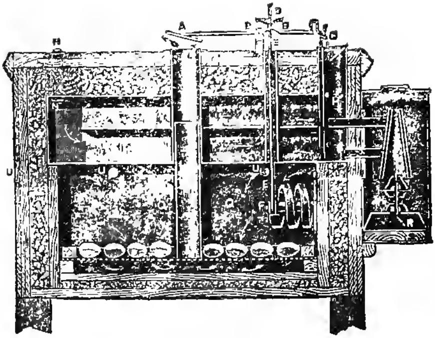


FIG. 29.

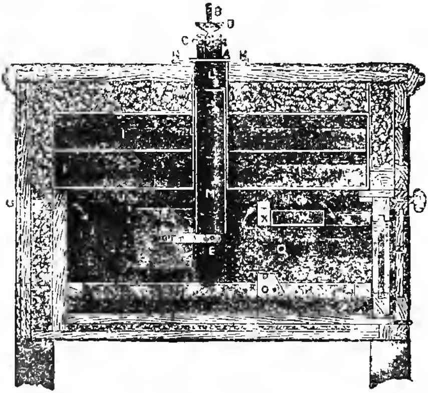


FIG. 30.

SECTIONAL DRAWINGS OF CHRISTY'S IMPROVED THERMOSTATIC INCUBATOR chamber, *i.e.*, the space enclosed beneath the tank. R is the lamp, and S the block which wedges the same up into the boiler. U U are the fresh-air inlet pipes.

The regulator consists of a helical or spiral coil, composed of two suitable metals, similar to one described later under the head of "Incubator Fitments."

The Perfection Incubator (A. E. W. Phipps, Harborne, Birmingham) is well constructed of 3in. tongued and grooved pine boards mortised and tenoned into corner pillars. The space between the inner and outer cases is packed with asbestos and silicate. The front of the egg-drawer and the body of the lamp-hood are also packed firmly with the same material, rendering the egg-chamber as immune from the deleterious effects of climatic changes as any incubator on the market.

The heat is supplied by radiation from a copper hot-water tank of extra depth, the contention being that a large volume of water, insulated on every side, is naturally less affected by climatic variation than a lesser quantity of water in a shallower tank. To prevent the tank from "sagging," and thereby bringing the source of heat into too close proximity to the eggs, the central pipe, through which the regulating spindle passes, is provided with a patent screwing device, which is fitted into the brass lever plate on the top of the incubator.

The ventilation and moisture supply are arranged as in the other hot-water incubators, the ventilating inlets being through holes in the double bottom. The regulator fittings are also similar to those described in another part of this book for use with the spirit capsule, which is the thermostat used.

The Nonpareil Incubator (W. Tamlin, St. Margarets, Twickenham, Middlesex).—In this well-made incubator the outer case is a mortised and tenoned frame with tongued and grooved panels, the corners being clamped in grooves together, then glued and dowelled. It is packed between the inner and outer cases with wool, forming a protective buffer against effects of the outside temperature. The hot-water tank is constructed with a kind of extension on the lamp side so that the water is immediately over and surrounding the oil or gas flame, the contention being that by this means the heat of the latter is more fully utilized. The water capacity of this copper tank is purposely reduced somewhat below that of other makes, the maker claiming that a quick change in the temperature of the room requires a correspondingly quick change in the heat of the tank, and the temperature of a large body of water would move more slowly than that of a smaller one. In the event of a sudden fall in outside temperature, a medium body of water would naturally, it is asserted, heat up more rapidly than a large one. The water in the tank is heated by circulating to and from the tank-extension surrounding the flame, no lamp-

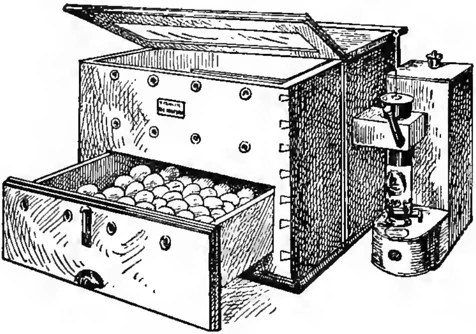


FIG. 31.—THE NONPAREIL INCUBATOR.

flues passing through the tank. The regulation of the heat is by means of the spirit capsule. In order to secure that the operation of this capsule shall be uninfluenced by any other heat than that of the air immediately above the eggs, a patent method of insulating it is used to overcome the conductivity of the metal bearings, and to break all direct contact through the stirrup fittings with the hot-water tank.

An automatic self-supplying lamp is supplied at an extra charge. It consists of a very large oil container, which, when filled, holds sufficient to keep the machine working for three or four weeks, automatically feeding the burner reservoir, and keeping the oil always at the same level around the wick.

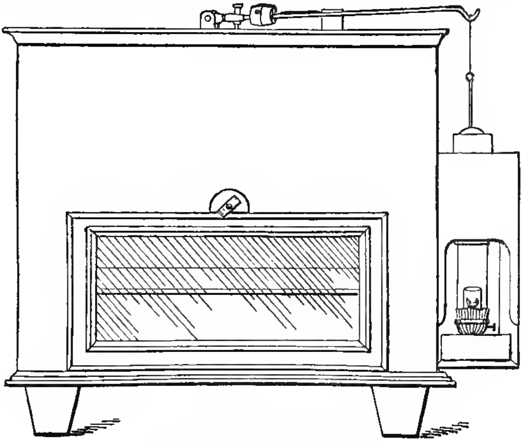


FIG. 32.—THE ASBESTIC HEN.

Toope's Asbestic Hen (Chas. Toope & Son, Stepney Square, High Street, Stepney, E.).—The top, sides, and bottom of this incubator (Fig. 32) are made of asbestos boards, the door and corner fittings being of metal. Through an air casement that surrounds the lamp the air passes into the egg-chamber, and after being partially warmed by the lamp, it comes in contact with the tubular tank, and is thoroughly heated before being drawn down between the eggs, By means of an air-shaft at the side of the machine the hot air is drawn down between the eggs, and passes out into an airshaft leading upwards to a valve on the top of the machine. By means of an adjustable slide controlling this valve the speed of ventilation, and thereby the degree of moisture, can be regulated.

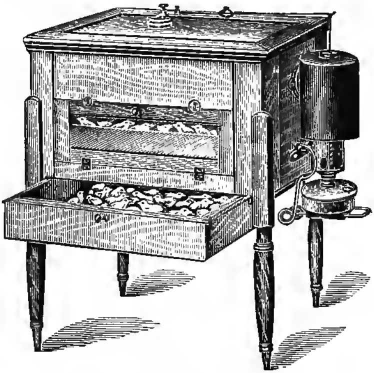


FIG. 33.—THE GLOUCESTER INCUBATOR.

The Gloucester Incubator (The Incubator Components Manufacturing Co., Gloucester).—This is a hot-air incubator (Fig. 33) similar to the Model, which differs from Cyphers and some other hot-air machines as originally constructed, in having no exhaust air-shaft drawing the air from the bottom of the incubator into the heater. The Gloucester is very carefully constructed of well-dried narrow boards, mortised, tenoned, screwed, and glued together to ensure the greatest possible durability. The warm air from the heater passes into the heating chamber, and is then diffused over and through a porous diaphragm and into the hatching chamber. Thence it passes downward around the eggs, and permeates a double porous diaphragm placed just above a shallow chamber, whence it is dispelled clear of the incubator. By these means the fresh warm air is evenly distributed over the hatching chamber, the downward movement being slow but sure. A proper degree of humidity is maintained in the following way: As the cool outer air passes into the heater, it gains rapidly in warmth, and thus its capacity for absorbing atmospheric humidity is increased. As this air cools and descends in the egg-chamber its moisture-absorptive capacity is reduced, and before leaving the egg-chamber it is made to give up its moisture to the higher-heated air above, leaving the incubator with about the same humidity as when it entered the heater. The exhalation of moisture from the eggs during incubation is also largely retained. The heater is constructed of galvanized iron with iron castings, no solder being used. An illustration of this heater is shown on page 92.

A space of about three inches is allowed between the front of the egg-tray and the door by which the chicks make their way down to the nursery beneath. A movable slip is provided for this space, upon which eggs can be placed till the first or second testing, when it must be removed to make way for the chicks to drop down. As soon as the chicks are hatched they are attracted by the light, and in moving towards it they naturally drop down into the chamber below provided for them.

E. H. Taylor's Incubator (E. H. Taylor, Welwyn, Herts), shown in Fig. 34, is well constructed with a double case of wellseasoned pine, and with dove-tailed corners. The tank is of stout copper, and is heated by the lamp-flue passing on three sides of it. The moisture supply and ventilation are on the same principle as in other hot-water machines already described, as also is the regulation of heat by means of a capsule. The sliding egg-drawer has an improved slotted bottom. A drying box is also provided.

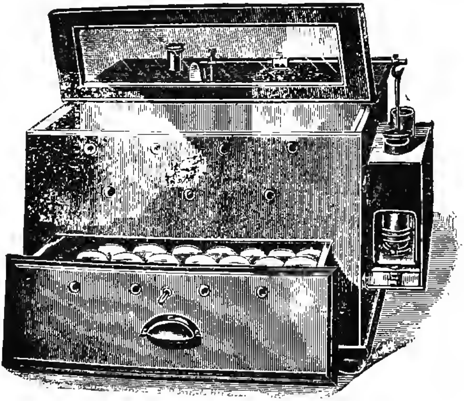


FIG. 34.—E. H. TAYLOR'S INCUBATOR.

The Danum Queen Incubator (W. T. Chafer, 52, Market Place, Doncaster).—The water in the tank is kept at the required temperature by circulating through a boiler round the lamp-flue, the lower pipe bringing the cooler water, and the higher pipe returning the hotter water, to the tank. Another unique feature of this incubator is that when the lever is raised (indicating sufficient heat in the egg-chamber), by an excellent arrangement, the lamp-flame is reduced, thus curtailing the supply of heat to the boiler, and at the same time saving oil.

The Prairie State Incubator (British Representatives, Robt. A. Colt, Ltd., 8 and 9, Chiswell Street, E.C.).—This is one of the oldest and best-known American Hot-air incubators. The lamp is placed under one end of the case. The chimney extends upwards into a flue, which passes through the upper part of the machine. The hot fumes pass into a galvanised iron reservoir, which covers the top of the egg-chamber, and this radiates its heat down to the eggs. No fumes from the lamp enter the egg-chamber. The temperature is regulated automatically by a U-shaped compound bar of sensitive metal, extending both above and below the egg-tray. The lower arm of this thermostat extending under the egg-tray is affected to a certain degree by the outside temperature. If the room grows

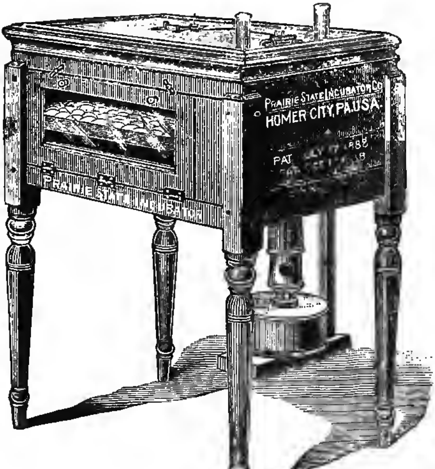


FIG. 35.—THE PRAIRIE STATE INCUBATOR.

colder, this lower arm contracts, changing the distance on the connecting rod which controls the valve, and thus throws more heat into the egg-chamber instead of allowing it to go straight up without passing into the heating resérvoir.

Fresh air enters the incubator from below through a tube surrounding the lamp-flue, where it is heated, passes upward into the top of the egg-chamber under the hot-air reservoir, where it is released over the moisture pans in the upper part of the egg-chamber. The warm moist air then descends through the eggs and escapes through ventilating holes in the bottom

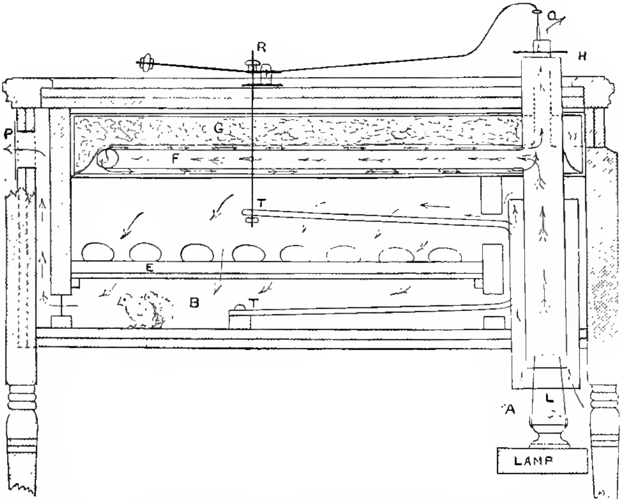


FIG. 36.—SECTIONAL VIEW OF THE PRAIRIE STATE INCUBATOR, SHOWING THE INTERNAL ARRANGEMENTS.

A, Inlet for Cool Air, which provides ventilation; B, Chicken Nursery; E, Egg-tray; F, Flue carrying hot air to be distributed above the eggs; G, Slag-wool Packing; H, Outlet for Hot Air, with damper to close same; L, Lamp-chimney; O, Outlet for Hot Air; P, Outlet for Warmed Air that entered at A; R, Regulating Screw; T, Thermostatic Bar.

and end of the incubator into a suction passage, which carries the air out near the top of the machine. The outlet of this suction passage is provided with a sliding cover, to adjust the ventilation, which may be increased or reduced by widening or narrowing the opening. Although moisture pans are provided, their use is not considered essential, except in dry situations and during the hot summer months. The sectional view (Fig. 36) gives an excellent idea of the principle of the hot-air machine.

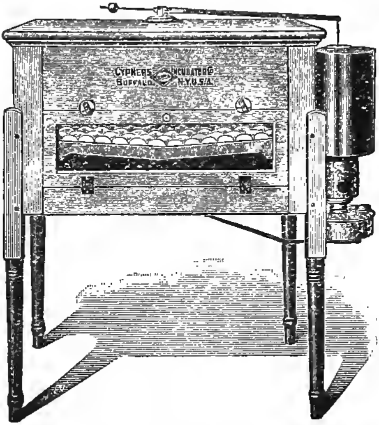


FIG. 37.—THE CYPHERS INCUBATOR.

This incubator is well constructed and made in probably more sizes than any other, viz., about fifteen.

The Cyphers Incubator (sold by the Cyphers Incubator Co., 119-125, Finsbury Pavement, London, E.C.). — This machine has made great headway. As shown in Fig. 37, the heater is outside the incubator, and is made of the best galvanised iron, covered with a jacket of asbestos. The lamp fumes do not enter the machine, but pass up the inside and down the outside of the fresh-air chamber or passages in the heater. The pure, warmed air flows into the heating-chamber above the eggs, and is there evenly diffused over and through a porous felt diaphragm into the egg-chamber. It then descends to and between the eggs and through a second porous diaphragm placed above a shallow chamber in the bottom, whence it passes out into the lower part of the heater and mixes with the fresh air being drawn by the heat into the heater. The warm descending air is evenly diffused over the egg-chamber, and the downward movement is slow but positive, giving sufficient ventilation without the risks attending direct upward ventilation.

No applied moisture is needed in these incubators, as the descending heated air, having a higher absorptive capacity for moisture, retains the moisture above and about the eggs, the cooling air leaving its moisture to a large extent behind it as it descends.

The regulator used in the Cyphers incubator consists of a combination of several pieces of steel and aluminium; these expand or elongate in different degree by the heat, which "bows" the aluminium owing to its greater expansion. By suitably amplifying this expanding and contracting movement, a very sensitive, durable, and reliable thermostat to operate the lever controlling the valve over the heater, is secured.

The egg-trays slope towards the centre of the incubator to facilitate turning the eggs and to make the heat over the eggs more uniform. A nursery is situated below the eggs. As soon as the chicks hatch, they move forward towards the light, and drop down over the front of the egg-tray on to the soft felt diaphragm below. This gets them out of the way of those not yet out of the shells.

The case is substantially constructed, excellently packed, and highly finished in every way.

The Model Incubator (made by Chas. A. Cyphers, of Buffalo, United States, and imported by Mountain Bailey, Woking Village, Surrey, England).—This differs in several respects from the "Cyphers" non-moisture incubator above described. The heater and regulator differ but slightly from the last-named, but the circulation of warmed air is achieved in a different manner. After being heated, the warmed air passes into the upper part of the incubator, and is diffused, as it descends, through a porous diaphragm into the egg-chamber. From the enclosed space below the eggs, in the Cyphers incubators, it is, as previously explained, conducted or drawn back into the lower part of the fresh air passage in the heater. In the Model incubator, the bottom is of porous material, through

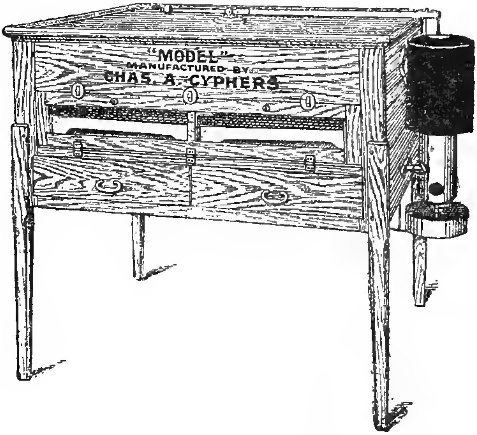


Fig. 38.—The Model Incubator

which the descending heated air mixes, inward and outward, with the outer fresh air, there being no direct return or suction of air to the heater. The air in the incubator, it is claimed, retains its humidity by its higher temperature and consequent higher moisture-absorptive capacity, and as it descends, gradually gives up or leaves its moisture behind it. On this principle the air in the incubator is always maintained at a uniformly higher degree of humidity than the outer air.

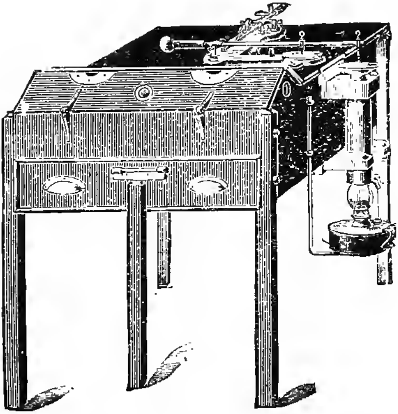


Fig. 39.—Clive's Incubator.

Clive's Incubator (Clive Brothers, 194, Aston Road, Birmingham). — In this hot-water incubator several new features are introduced. The regulator is large, and has two levers, one working upon the other, thus amplifying the lifting movement of the capsule very considerably. The large aluminium dampers and the funnel top to the lamp and tank flues cause a quicker response to rises and falls of temperature by permitting the surplus fumes from the lamp to escape more quickly. A very small rise, also, of the lamp damper causes a draught of cold air to pass back through the tank flue and out between the lamp damper and funnel top of the tank, thus preventing the possibility of the tank and egg-chamber getting too hot. The water in the tank is heated by circulating to and from the tank from a water jacket or boiler surrounding the lamp flue (Fig. 39). The moisture tray extends from the centre of the incubator underneath to the water tube, around the lamp flue, from which it receives the necessary heat. The temperature of the water in this vapour tray is increased or diminished by sliding it nearer to or further away from the tank-tube. Fresh air passes in through the shallow ventilation passages, passes over the water in the trays, taking up moisture in so doing, and then into the incubator through a large hole in the centre. After passing through the egg-chamber it is drawn out through four shafts situated at the four corners of the tank. These four shafts meet in one outlet under the air damper. The usual drying-box for newly-hatched chicks is provided.

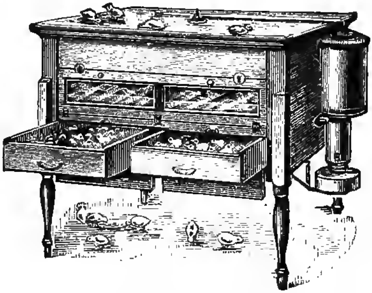


FIG. 40.—THE GLEVUM INCUBATOR.

The Glevum Incubator (Horace W. Stephens, Calton Road, Tuffley, Gloucester).—A hot-air machine of the non-moisture type.

It is carefully constructed of yellow pine, the framework being mortised, tenoned, and glued. The walls are double, well packed between with cotton wool, the outer case consisting of narrow two-inch boards to counteract the drawback of warping experienced in wide boards. The heater is similar to the one described on page 92. The fumes from the lamp do not enter the hatching chamber. Pure heated air enters the top of the incubator through a pipe, and after being liberated it diffuses gradually downward through a thick, porous diaphragm into the egg-chamber. Then descending further it passes through a second diaphragm of adjustable thickness, forming the incubator bottom, out into the open air. To prevent a too rapid flow of air through the incubating chamber during cold weather, the lower diaphragm is of three thicknesses. As the weather gets warmer, one, two, or all three layers can be removed. The regulator is well finished, either a capsule or a zinc and steel thermostat being provided, similar to those already described. A nursery under the egg-drawer is provided. The Glevum Incubator is shown in Fig. 40, page 65.

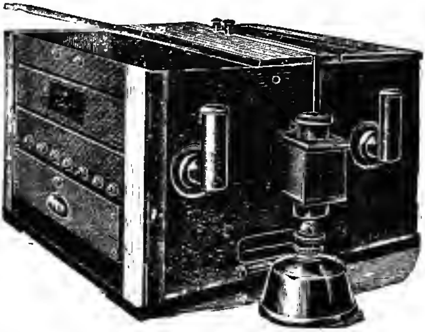


FIG. 41.—THE J.M.D. INCUBATOR.

The J.M.D. Incubator (The J.M.D. Live Stock Appliance Co., Blackburn) is a hot-water one (Fig. 41) differing in some details from the usual type. Hot flues, imparting heat to the tank, pass through the centre and return on the front and back, and have two outlets instead of the usual one. Instead of the sliding balance weight on the capsule regulator a spiral spring is used which can be operated by a thumb-screw. Pressure, as required, can thus be placed on the lifting power of the capsule, to prevent the damper over the lamp from lifting, and thereby discharging surplus heat, till the required temperature in the egg drawer is reached.

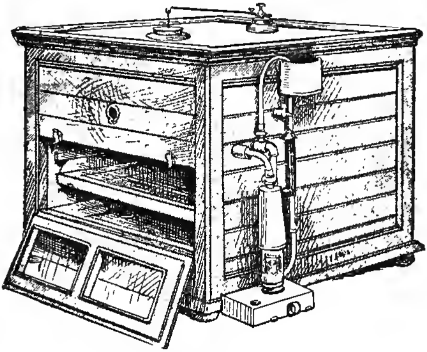


FIG. 42.—THE TRIUMPH INCUBATOR.

The Triumph Incubator (William Lea, Royal Appliance Works, Birkdale, Southport).—A well-constructed machine (Fig. 42) in which the heat is supplied by means of a boiler and circulating hot-water pipes instead of a hot-water tank. The case is very similarly constructed and packed to that of a tank machine. The inlet ventilation at the bottom is also similar, but the outlet ventilation, and also with it the internal temperature, is controlled by means of the valve N (in the diagram Fig. 43) on the top of the outlet air passage S S.

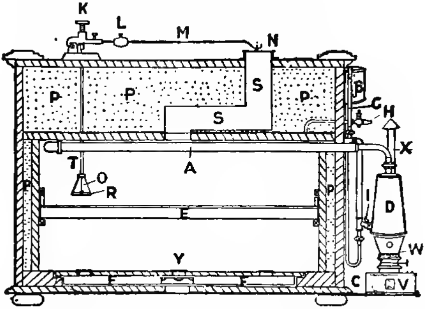


FIG. 43.—SECTIONAL VIEW OF TRIUMPH INCUBATOR.

The diagrams (Figs. 43 and 44) with the following explanation show clearly the construction, method of heating, ventilation, and moisture supply of this incubator. A is the heating-coil.

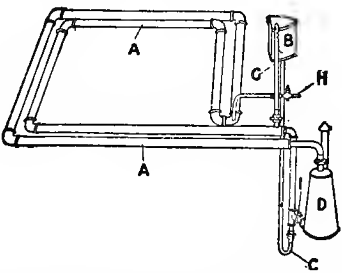


FIG. 44.—HEATING SYSTEM OF TRIUMPH INCUBATOR.

B, feeding cistern, which should always contain water when the machine is in operation. C, tube whereby water is conducted from feed-cistern to boiler and thence to heating-coil. D, boiler. E, egg-tray. F, moisture-tray, which should always contain damp peat moss. G, exhaust-pipe. H, tap (only affixed to the larger incubators with double row of pipes), to allow the air to escape from the heating-coil when the machine is being filled with water before commencing operations. When water begins to run from this tap the heating-coil and boiler are full and ready for lighting up. I, tap for emptying water from boiler and coil when necessary. K, screw for adjusting regulator. L, sliding weight for regulating the temperature at which valve N will rise: it may be regulated. M, lever rod or arm. N, valve or damper. O, lifting-rod or centre rod connecting capsule with lever. P, insulating or non-conducting material. R, capsule. S, ventilating tube controlled by valve N. T, brass tube in which lifting-rod O works. V, oil tank. W, copper flame-screen, with mica window through which flame can be observed. X, brass chimney affixed to boiler. Y, diffusing-board over moisture tray.

Double coils are used in the large incubators only, one coil only being necessary in the smaller machines.

The Standard Incubator (The Dairy Outfit Co., King's Cross, London) is of the hot-water type. The outer case has dove-tailed corners, and both outer and inner cases are carefully constructed to withstand the changes of temperature to which incubators are subjected. The tank and regulator fittings are also well made and of good material. The lamp is provided with a self-filling reservoir, a continuous supply of oil flowing into it automatically as required. The regulation is by means of the spirit capsule.

CHAPTER IX.

INCUBATOR FITMENTS.

The J-Tube Regulator.—A very useful regulator may be made thus: A piece of glass tube, not less than ½in. bore, is bent into the form of the letter J. The short arm is about 3in. long, hermetically sealed, and preferably with about 1in. of the end blown out into a spherical shape. The longer arm should be about 6in long, and, of course, open. Fasten this tube to a suitable wooden stand so that when fixed in the incubator the top of the short arm is about level with the top of the eggs. In the closed end is imprisoned by mercury a small quantity of spirit, the vaporisation of which pushes the column of mercury up the open arm. Resting on the mercury,

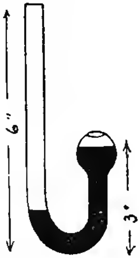


FIG. 45.—J-TUBE REGULATOR.

in the open arm, is a light, easy-fitting cork (slightly conical-shaped for preference, and about ⅓in. deep or less) to which is fastened a light, lifting wire, impinging against a small disc at the bottom of an adjustable screw in the lever operating the damper or ventilator above.

To get the spirit and mercury into the tube, proceed as follows: Pour in sufficient mercury to fill the closed arm and about ½in. of the open arm. To remove the air and admit the mercury tilt the tube thus, . Next pour on the top of the mercury sufficient spirit to occupy about ¼in. of the tube, and by tilting the tube so, , carefully work it round into the closed end. Then admit just one or two bubbles of air, and the regulator is ready for work. This bubble of air is necessary also for the successful working of other spirit-regulators. When complete, the mercury need only rise from ½in. to 1in. above the bend at the bottom of the tube.

The chief fault of this regulator is that the cork float is liable to stick if any grit, or even much dust, should get into the tube, thereby causing it to be buried in the rising mercury, the result being that the damper fails to open when the proper temperature is reached. The lifting power of this cork float is also slight; consequently undue pressure from the lever above, unless the latter is very carefully balanced by the balancing-weight, is sufficient to press it into the mercury. Otherwise this thermostat is extremely sensitive.

The liability of the ordinary J-tube float to stick and fail to do its work is overcome by a float contrived and adopted by the writer. It consists of an easy-fitting glass tube, about 2in. long, sealed at both ends, to the hooked top of which is fastened the wire lifter. The float has this advantage: it cannot stick or get buried in the mercury, owing to the lightness and buoyancy of the enclosed air. If extra pressure should be exerted from above, the float simply sinks a little into the mercury till the weight of displaced mercury is equivalent to the pressure put upon it, at which depth it rises and falls with the temperature. The greater the pressure, the greater is the lifting power.

Pear-shaped Regulator.—This regulator consists, as will be seen by Fig. 46, of two parts, a pear-shaped glass vessel suspended inside a lower vessel by a wire from the lever above the incubator. The former vessel is charged with the spirit—3 of ether to 1 of methylated spirit—and mercury. As the dilute ether volatilizes, the consequent forcing out of the mercury leaves the vessel lighter, and being hung to and balancing the lever above, the damper is permitted to rise. The principle employed, it will be seen, is the release and reclamation of the mercury as it is expelled or drawn in by the

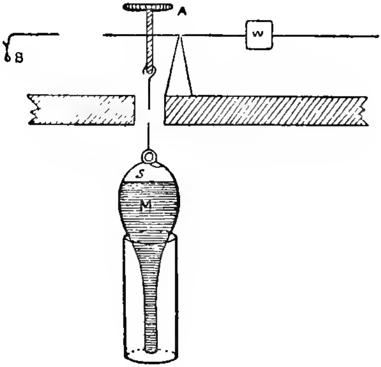


FIG. 46.—PEAR-SHAPED REGULATOR.

S, Spirit; M, Mercury; A, Adjusting Screw; W, Balance Weight; B, Damper.

vaporising or condensing of the spirit. The inner vessel is a plummet, getting lighter or heavier, according to the temperature of the incubator.

In fixing, the spirit should be level with the top of the eggs and the thermometer bulb, and the neck of the inside vessel must hang clear of the bottom of the outside one, to allow a free passage for the mercury. When the desired temperature is reached, the balance-weight (W) and the adjusting screw (A) can be easily manipulated so that the damper may be slightly open, and the neck of the upper vessel just clear of the bottom. To charge the regulator, pour about as much mercury into the pear-shaped vessel as is represented in the illustration (Fig. 46). On the top of this pour the spirit. Place the outer vessel, upside down, over the neck of the pear-shaped one, and quickly reverse, to bring the glasses into position. The suspending wire should be made plenty long enough at first, afterwards cut to the desired length, and hooked into the adjusting screw, by means of which it can be finally adjusted. In handling this regulator be careful not to lift it up, or you may unintentionally release the mercury, and have to refill.

Durnford's Patent Metal Regulator.—Metal regulators have the advantage over others in not being liable to break, or get out of order, and are not subject to variation with changes in the barometric pressure of the atmosphere, but they are hardly equal in sensitiveness to the best spirit-regulators, as it is a physical impossibility for any solid to expand and contract with the same delicate sensibility as either a liquid or a gas.

Durnford's Patent Regulator consists of a long narrow plate of zinc, one end only of which is fastened to an iron framework, the other end being free to expand. The iron framework is a kind of tray surrounding the sides and bottom of the zinc and supporting it, and is fitted at one end with a ledge, or stop. This ledge, or stop, is at the free end, but beneath the level of the zinc. An iron rod, with a broadened end, or foot, turned at right angles to the rod's length, is fixed over the zinc plate.

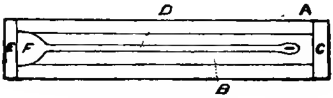


FIG. 47—Plan.

In the accompanying diagrams, A is the iron frame, B the zinc-plate fixed at C, and free to expand at the other end. D is the iron rod, the bottom part of the foot resting against the stop E, the upper part of the foot receiving the pressure at F of the zinc plate B as it lengthens with heat. The effect of this pressure is to raise the arm D, in the free end of which is a lifting-rod G, which raises the damper on the incubator. In the illustrations (Figs. 47 and 48), the zinc plate, the stop, and the foot of the iron rod are, for the sake of clearness, represented as not touching each other.

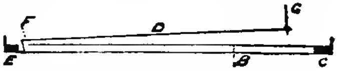


FIG. 48.—Section.
DURNFORD'S PATENT REGULATOR.

The Spiral Metal Thermostat.—This regulator consists of a helical or spiral coil, composed of two suitable metals. It is well known that all metals do not expand with heat at the same rate. For instance, if the volume of any solid at freezing-point be represented by 1, the following table shows the linear expansion for each additional degree of heat between 32deg. Fahr. (freezing-point) and 212deg. Fahr. (boiling-point).

Glass	·0000046	Silver	·0000106
Platinum	·0000048	Tin	·0000120
Iron	·0000065	Lead	·0000160
Brass	·0000104		

If two thin strips of metal whose co-efficients of expansion, as shown above, vary considerably, as platinum and tin (the expansion of the latter being over three times as much as the former), were joined together and heated, it is evident that the double strip would gradually bend into the form of a curve, with the tin on the outside and the platinum on the concave side of the curve, in consequence of the greater linear expansion of the former than of the latter. For convenience in use, and in order to occupy less space, this double strip of metals is bent into a spiral coil, free, of course, at one end. If the tin is inside, by its expanding more largely than the platinum, the tendency of the coil will be to unwind or straighten out at the free end. This movement or force constitutes the motor to operate, by means of a pull-wire, the lever on the incubator.

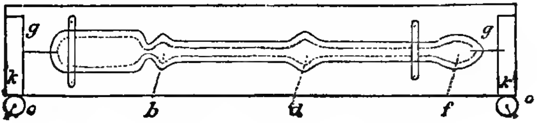


FIG. 49.—PATENT ELECTRIC ALARM THERMOSTAT.

Patent Electric Alarm Thermostat.—The following is a brief description of a patented invention, which sounds an alarm-bell should the heat in the incubator rise above the required degree. This thermostat has the form of a mercurial thermometer, provided with expansion chambers (*b*, *d*, and *f*)

The mercury is so adjusted that it expands, and fills the expansion-chamber (*f*) at a certain fixed temperature, completing a circuit through platinum wires (*gg*), plates (*kk*), the binding-screws (*oo*), and battery in connection therewith, which latter causes an alarm bell to ring.

In an incubator the hottest air is in the top, each successive layer below being slightly cooler than the one immediately above. In practice, the position of this electric alarm is adjusted at such a height above the eggs, that when the thermometer, placed on the latter, registers 104deg., the electric circuit is closed by the mercurial connection, and the alarm is sounded. If, for instance, it is found, that the thermostat, placed 2in. above the eggs, gives the alarm when the thermometer on the eggs reads only 102deg., it is evident that, by lowering it a little into a layer of air a trifle cooler, one or two more degrees of heat would be needed to close the mercurial connection. This would permit of the eggs reaching about 104deg. before the alarm was given.

Alcohol Thermostat.—The accompanying drawing gives an idea of a thermostat which depends for its operation on alcohol, which expands and contracts considerably with changes of temperature.

AA is a long tube of glass, sealed at one end. It is placed immediately above the eggs, and varies in length according to the size of the incubator. This tube is filled with alcohol, imprisoned by mercury, the latter extending from about B (below the bend in the tube), round through the rubber tube (C) into the glass overflow-tube (D), which is affixed to a weight (E) suspended by a wire to one end of the lever (F).

The rubber tube (C) is secured to tube A A by a rubber cork with a small hole through the centre.

The mode of operation is this: As the temperature rises, the alcohol in the long glass tube expands, thereby forcing a little of the mercury from B, round the curve and up towards or into the expansion tube (D), and this increased weight acting on the lever already balanced by the sliding weight (O) causes the damper (H) to lift. When the temperature falls, the alcohol contracts, and the mercury is drawn back again by its own weight into the tube (B).

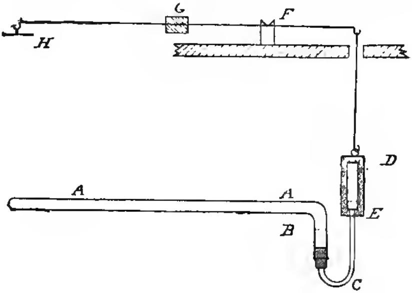


FIG. 50.—ALCOHOL THERMOSTAT.

Rubber Thermostat.—There are several ways of utilising the expansive force of hard vulcanised rubber for the purpose of regulating the heat of incubators. Fig. 51 shows one method. A A consists of a long strip of wood, securely fastened to a piece of hard rubber by small brass rivets. Wood and

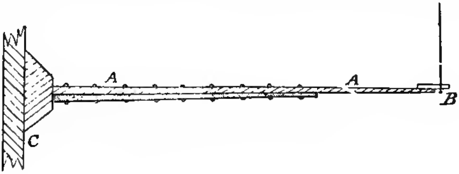


FIG. 51.—RUBBER THERMOSTAT.

rubber are each about ¼in. thick and 1¼in. wide, tapering to 1in. at the free end (B). This thermostatic bar is fastened firmly to the side of the incubator at C, so that it will stand out horizontally a little above the eggs. The rubber, which is on the underside, expands with heat and bends the free end (B) slightly upward. Contraction of the rubber brings B down again. This slight motion is multiplied many times by the lever which it operates. It is probable that a thermostat of this description would soon lose its potency, as the rubber, by use, would lose its power of regular expansion and contraction.

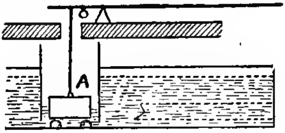


Fig. 52—Sectional Elevation.

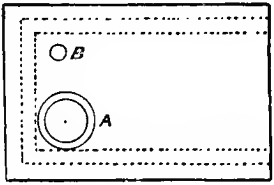


Fig. 53—Plan.

Regulation by the Expansion of Air.

Regulation of Incubators by Expansion of Air.—The following method of regulating the heat by the expansive force of compressed air has been recommended by some authorities.

Fig. 52 represents the sectional elevation of an incubator tank, say 18in. by 12in. by 4in. deep, and Fig. 53 the plan. A is a cylindrical hole, or well, 4in. in diameter, let into and soldered air-tight to the top of the tank, and reaching down to within about ⅛in. of the bottom. In this well is placed a very freely-fitting, light, air-tight float made of tin, suspended from the lever on the incubator. The tank is filled through a pipe (B), (which must afterwards be screwed up and sealed air-tight) to within ½in. of the top with hot water. The water in the well is now laded out to within 1in. of the bottom to admit the float. When ready for work, the level of the water in the well is much below that in the tank. As the area of the water in the tank is about thirteen times that of the well, the variation in the level of the float, consequent upon the expansion or contraction of the compressed air in the tank, will thus be much greater than the variation in the water-level of the tank. This rising and falling of the float is the motive-power to work the lever and damper above.

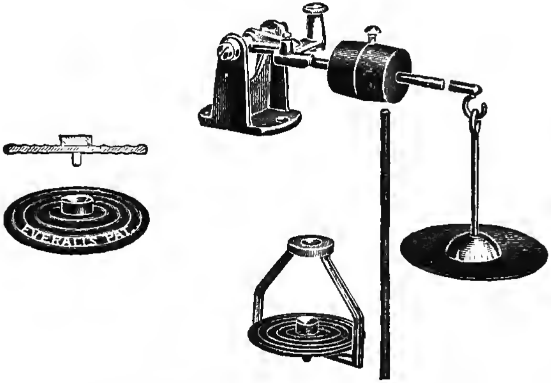


FIG. 54.—EVERALL'S NO. 1 PATENT CAPSULE REGULATOR.

Everall's Regulators (The J. B. Everall Manufacturing Co., Hayes, Middlesex).—Everall's No. 1 capsule regulator consists of a hinged stand, made to allow the lever rod to be adjusted for length without cutting. A milled head screw to adjust the lifting rod, a sliding weight, lever, steel lifting rod, capsule holder, damper with suspender to drop through when resting on the flue, and a patent corrugated capsule and screws for fixing are provided (Fig. 54).

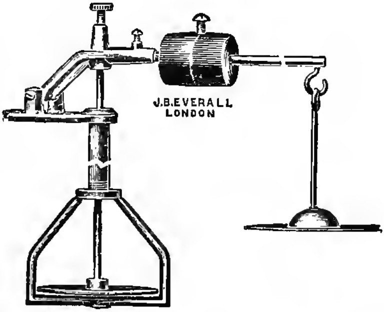


FIG. 55.—EVERALL'S NO. 3 LOW PATTERN CAPSULE REGULATOR.

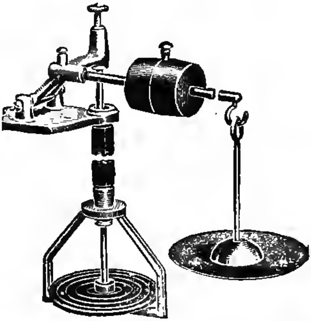


FIG. 56.—EVERALL'S NO. 4 LOW PATTERN CAPSULE REGULATOR.

The No. 3 low pattern (Fig. 55) is the same, generally, as No. 1, except that the lever rod socket is in the centre of the hinge, and does not allow the lever rod to be adjusted without cutting. This regulator is independent of the tank for the support of the capsule.

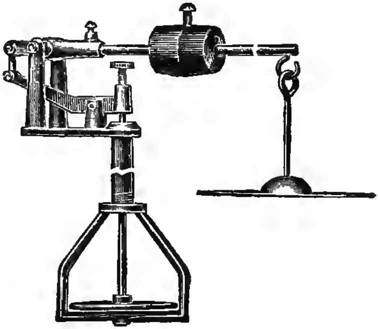


FIG 57.—EVERALL'S NO. 5 COMPOUND LEVER REGULATOR.

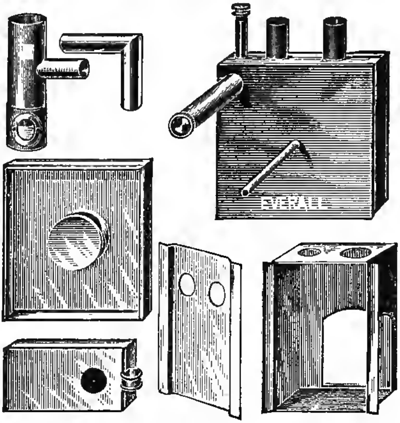


FIG. 58.—FITTINGS FOR MAKING HOT-WATER INCUBATOR.

The No. 4 low pattern (Fig. 56) is much the same as No. 3, except that the lever rod socket is at the side of the stand

and lever, and allows adjustment of the lever rod for length without cutting. Dampers are made in three sizes—2⅝in., 3in., and 3½in. in diameter; and capsule holders or stirrups 2¼in., 3in., or 3¾in. in depth.

The No. 5 compound lever regulator (Fig. 57) is intended for atmospheric machines, or for incubators where space only permits the use of a short lever rod. It can, however, be used for a tank machine if a longer lever rod be substituted.

The accompanying illustration shows a complete set of the remaining fittings required in the making of a hot-water incubator (Fig. 58). The set includes a tank of cold-rolled, hard, bright copper, with large flues, and a tube for the regulator rod to pass through, filling screw and draw-off outlet, also elbow, tee, hood and side lining, damping tray, and oil container for the lamp.

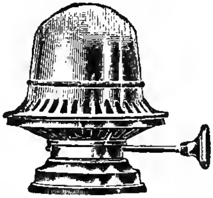


FIG. 59.—THE "SILVER" CHIMNEYLESS BURNER.

Fig. 59 is a drawing of the "Silver" chimneyless burner, with a movable cone and screw collar adapted for use with tank machines.

The Incubator Lamp Hood (The J. B. Everall Manufacturing Co., Hayes, Middlesex) (Fig. 60) is made of strong tinplate, stove-enamelled black, the upper part being packed with asbestos wool to retain the heat. The flanged side for fixing to the incubator is recessed, giving an air space between the latter and the hood as a protection against the heat of the lamp. The lamp reservoir is fitted to a tinned iron shoe furnished with a spiral spring to bring the lamp close up to the flue, and the short lamp-chimney is fitted with a non-conducting holder enabling it to be removed while hot.

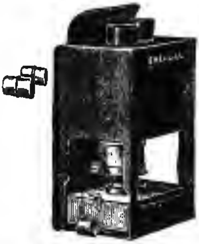


Fig. 60.—Incubator Lamp Hood.

Mounting Capsule Regulators.—The sectional drawing here given (Fig. 61) shows an excellent method of mounting the capsule to avoid the heat of the hot-water tank being conducted through the stirrup direct to the capsule, and by so doing rendering it less susceptible to the fluctuations in the temperature of the *air* in the egg chamber. The tube through the tank should be about ⅞in. in diameter, and the corks should be bored

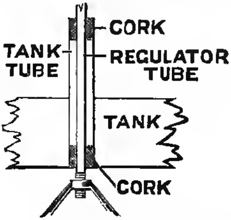


Fig. 61.—Method of Mounting a Capsule Regulator.

centrally. Soldering this tube to the tank is unsatisfactory for the above reason. The corks, as in the sketch, being non-conductors of heat, effectively insulate the metal stirrup or capsule table, and with it the capsule, thus leaving the latter subject to the surrounding air only.

Everall's Humidity Gauge (The J. B. Everall Manufacturing Co.).—The amount of moisture recommended by different incubator operators as desirable to secure best results varies widely. Moreover, until this excellent instrument (Fig. 62) was put on the market there was no convenient and at the same time reliable method of ascertaining the exact degree of humidity actually present, as this depends upon so many conditions, namely, the moistness and temperature of the incoming air, the rate at which it passes through the machine, the position of the water-supply, the area of the latter exposed to evaporation, the stage of incubation, etc. More than one incubator has come under the notice of the writer which has evaporated large quantities of water, but still, owing to the rapidity of the air-current through the machine, has dried the eggs too much. The *amount* of water evaporated is a very unreliable measure of the drying effect, or otherwise, of the atmosphere of the egg-chamber. For further information on this subject the reader is referred to "Incubation, Natural and Artificial," by the author of this book.

Everall's Humidity Gauge, or Hygrometer, is a modification of the wet and dry bulb thermometer. The latter consists of two thermometers. The bulb of one is covered with muslin, which is connected, by means of a thick strand of cotton, with a vessel of water; the cotton strand sucks up the water to the muslin enclosing the bulb, just in the same way that the wick of a candle sucks up the melted wax or fat. When water passes from the state of liquid to that of vapour heat is absorbed. A drop of water on the hand, in its evaporation, produces the sense of cold, spirit of wine and ether producing even greater cold, because of their greater volatility. Owing to the loss of heat, by evaporation, from the muslin enclosing the bulb, the heat registered by this thermometer is lower than that of the exposed thermometer. If the air were charged with moisture to the extent of its capacity, or, in other words, if it were saturated, no evaporation would take place from the covered bulb, consequently there would be no loss of heat, and the two thermometers would register alike. On the contrary, if the atmosphere were very dry, evaporation from the covered bulb would be great, the resultant loss of heat would also be great, and the difference in the readings of the two thermometers would be wide.

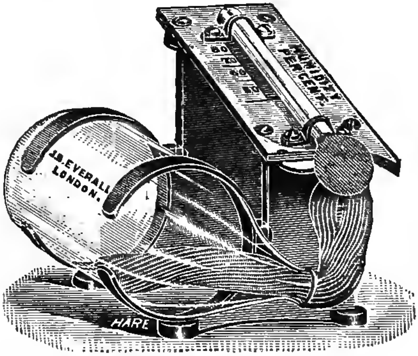


FIG. 62.—EVERALL'S HUMIDITY GAUGE.

As a thermometer is provided with every incubator, and as it is only necessary to register the humidity at the temperature of 104deg. Everall's Incubator Humidity Gauge dispenses with the uncovered thermometer, and in place of the covered thermometer above referred to, a hygrometer measuring the degree of humidity at 104deg. only is used. It acts in this way: When the exposed incubator thermometer reaches 104deg., and, for the sake of illustration, should the moistness of the egg-chamber be exactly midway between perfect dryness and saturation—that is, if it should have a humidity of 50 per cent.—the reading of the mercury would be indicated on the scale at the figure 50. Again, the incubator thermometer being still at 104deg., if the air should be damper—containing, say, 70 per cent. of its full moisture capacity—less evaporation would take place from the covered bulb, less heat would be lost, and the reading of the hygrometer would be higher, namely, at 70. The instrument is scaled from 50 to 80.

Thermometers.—In artificial incubation nothing plays a more important part than the thermometer, and as many of the cheap ones sold are entirely unreliable, and worse than worthless, a few words in regard to them may be of use.

Thermometers should have the degrees marked on the stem, as those mounted on wood or metal have the scale stamped on the latter by the hundred at a time, the sealed glass tubes being afterwards fitted to them. The rise and fall of the mercury in the tube may, or may not, coincide with the scale on the wood or metal mount already prepared, in some cases the reading being several degrees out, and, at the best, only correct at one or, at most, two places. Moreover, those mounted on wood, or with spirit in place of mercury, do not respond quickly enough to any variation of temperature that may take place. Even thermometers etched on the stem are not necessarily reliable. After being sealed they should be kept a considerable time before being scaled, otherwise the subsequent contraction of the glass tube causes the mercury to indicate slightly higher than the correct temperature. Any thermometer, however, may be used in an incubator after it has been tested by comparison with one known to be correct, if proper allowance is, of course, made for the amount of its inaccuracy.

In the Nonpareil Incubator (W. Tamlin, St. Margaret's, Twickenham, Middlesex), described on pages 53-55, an L-shaped thermometer is used, the bulb-end of which passes into the drawer, while the scale, indicating the temperature, is held to a metal plate on the outside of the drawer by means of clips. The temperature of the drawer can thus be ascertained without the necessity of withdrawing the thermometer and the consequent possible lowering of the reading of the thermometer in doing so. Also, by adjusting the screws which hold the metal plate, the thermometer can be raised or lowered to suit any sized eggs, by varying the position of the metal plate, It can be removed in the same way as a straight one, when turning the eggs, by simply releasing it from the metal clips.

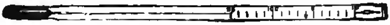


FIG 63.—THE STRAIGHT DRAWER THERMOMETER.

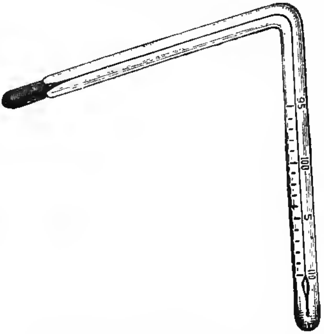


FIG. 64 —THE L-SHAPED THERMOMETER.

The following incubator fittings of various kinds are made by the J. B. Everall Manufacturing Co., of Battersea Works, Hayes, Middlesex: The straight drawer thermometer (Fig. 63) is scaled and figured from 95deg. to 110deg. on the tube; 104deg. is indicated by a red arrow; an expansion chamber is provided at the top to prevent bursting when heated above 110deg.; and the bulb is cylindrical and very sensitive.

In the L-shaped thermometer (Fig. 64), special care is taken in the construction to prevent the mercurial column becoming disunited at the elbow as in some thermometers. It is, in other respects, like the straight one above described, both of which are made in various sizes, from 6in. to 12in. in the straight ones, and from 3½in. by 3½in. (for atmospheric machines) to 3in. by 7½in. or more in the L shape.

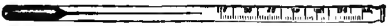


FIG. 65.—THE TANK THERMOMETER.

The tank thermometer (Fig. 65), for registering the heat of the water, is divided on the tube from 120deg. to 180deg., and they are made either 13in. or 15in. long. With any of these thermometers a "Kew" Observatory Verification Certificate can be supplied at an extra charge.

Everall's Hanging Thermometer (Fig. 66) may be suspended immediately above the eggs, and is suitable for hot-air incubators having glazed doors.

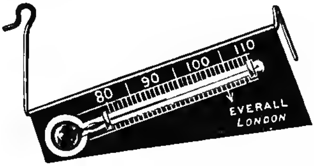


FIG. 66.—EVERALL'S HANGING THERMOMETER.

The Everall Co.'s aluminium and steel regulator, illustrated in Fig. 67, consists of bands or thin bars of these metals, which expand in different degrees, causing an upward bulging of the aluminium by its greater expansion, and which operates the lever by means of the lifting-rod. Although not so sensitive or so powerful as the spirit capsule or disc form previously described, these regulators are very convenient and are not affected by changes in the barometric pressure. For places abroad, situated at a great altitude, they are especially suitable, as their correct working is not affected by altitude.

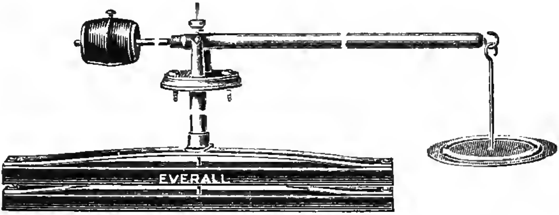


FIG. 67.—EVERALL'S ALUMINIUM AND STEEL REGULATOR.

Automatic Gas Regulating Valve (The J. B. Everall Manufacturing Co., Hayes, Middlesex.)—It has been long known that gas could not be used for working incubators, on account of the fluctuations of pressure from the gas mains. The device shown in Fig. 68 (made by the above, also by the Incubator Components Manufacturing Co., and other firms),

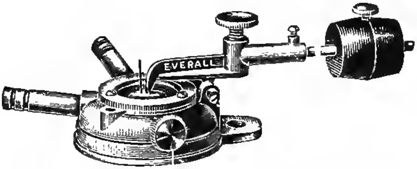


FIG. 68.—EVERALL'S AUTOMATIC GAS-REGULATING VALVE.

however, automatically corrects these variations. In action it is very sensitive, quickly responding to any variation in the pressure of gas, and regulating the flame to a uniform height, night and day. Its usefulness is such that it may be applied to other work as well as being used for incubators.

The Extension Feeder Oil-container for Lamps (The J. B. Everall Manufacturing Co.).—This consists of an extension of the reservoir, supplied with a filling-hole with a screw cap, which enables the lamp to be charged with oil without the necessity of removal from the hood. The extension also answers as a handle by which the lamp may be removed, and is fixed either to one side of the oil-container or in the centre.

The "Chekflo" Oil-can (Everall & Co.) is an improved paraffin can (see Fig. 69) designed for replenishing lamp reservoirs, and is so constructed that when the oil in the latter reaches the spout of the filler, the ingress of air into the can is stopped, and as a consequence the outflow of oil is checked, as the oil will not leave the can unless an equivalent space can be taken up by the inflowing air. This is effected by the can having an air-tight stopper.

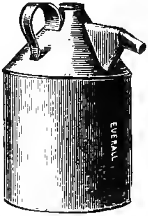


FIG. 69.—THE "CHEKFLO" OIL-CAN.

Along the top of the inside of the spout a small air-tube is provided, which permits air to enter the can as the oil runs out until the entrance to this air-tube at the end of the spout is closed by the oil in the reservoir.

Hot-air Incubator Heater.—Fig. 70 shows the heater generally used in hot-air non-moisture incubators, and made by the Incubator Components Manufacturing Co., Gloucester, and by the J. B. Everall Manufacturing Co., Hayes, Middlesex. It is divided into three compartments. The fumes from the lamp pass up the inside flue and down the outside of the fresh air inlet passage. The fresh air thus gains heat by contact with the hot walls on either side of it. The fresh air passage leads, by a pipe near the top at right angles to the heater, into the upper part of the incubator. Another pipe or tube near the bottom exhausts the air from the bottom of the incubator into

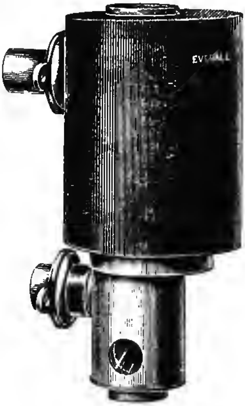


FIG. 70.—HOT-AIR (NON-MOISTURE) INCUBATOR HEATER.

the fresh-air passage again, where it mixes with the fresh ingoing air. The heater is covered with a thick coat of corrugated asbestos, as the efficacy and economy of this method of supplying heat to the egg-chamber depends mainly on the quality of the packing and efficiency in retaining heat. A small window is provided, through which the flame of the lamp may be seen.

New Hot-air Heater (J. B. Everall Manufacturing Co. and Incubator Components Manufacturing Co.).—The accompanying drawing (Fig. 71) illustrates a new kind of heater recently adopted in some hot-air incubators. It is, as in the preceding one, of iron castings riveted or bolted together, air-tight and smoke-proof, without reliance on solder. The fumes from the lamp pass up flue 3, then by a cross flue 8 into flue 9, through which they descend and escape at the bottom, none going into the egg-chamber. The fresh air enters at the bottom of the passage 7, 7, becomes heated by proximity to the central flue

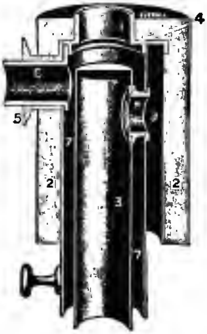


FIG. 71.—SECTIONAL VIEW OF NEW HOT-AIR HEATER.

3, and passes into the incubator, when the damper is down, by tube 6. When the damper rises, the surplus heated air escapes through the opening 1, controlled by the damper. There is no exhaust-pipe, as in the older style of heater, drawing the air from the bottom of the incubator into the lower part of the fresh-air passage 7, 7. In incubators having this style of heater, the ventilation is by inward and outward diffusion of air through the porous felt bottom of the incubator.

CHAPTER X.

A HOME-MADE INCUBATOR.

For the convenience and help of those who, from economical or other reasons, may prefer to attempt a home-made incubator, the following instructions may be desirable. Anyone, however, who has read carefully the preceding chapters, and who has noted the essential features necessary to successful incubation, and the salient points in the machines which have been

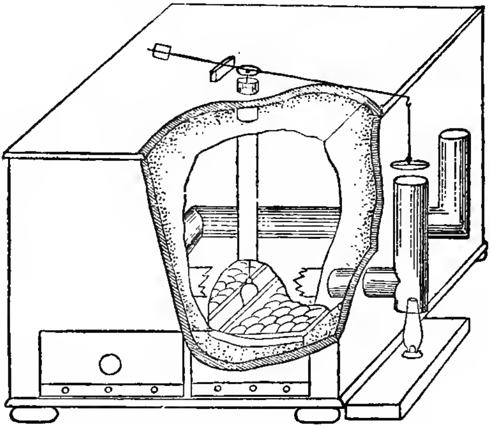


Fig. 72.—Home-made 36-Egg Hydro Incubator.

described, will find little difficulty in constructing a very serviceable incubator, even without the assistance of further instructions.

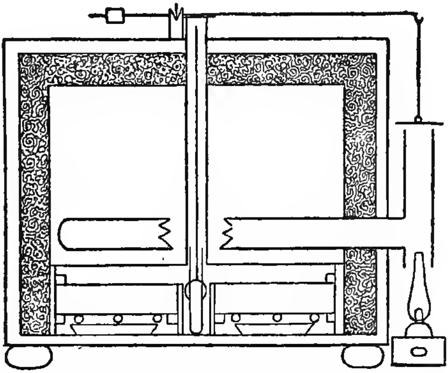


FIG. 73.—LONGITUDINAL SECTION OF 36-EGG INCUBATOR

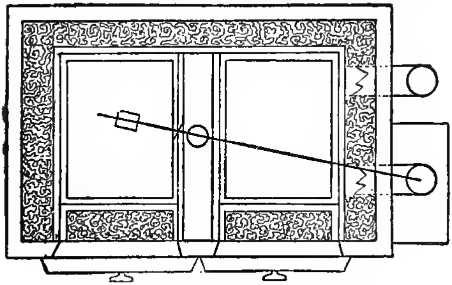


FIG. 74.—PLAN OF 36-EGG INCUBATOR.

Of the three types of machines—namely, the hydro, in which the heat is supplied by a hot-water tank, those in which the fumes of the lamp are allowed to enter direct into the egg-chamber, and those in which the heat is supplied by radiation from hot-air pipes, &c., the second perhaps presents least difficulties in the way of an amateur making his own; but although very satisfactory results can be obtained from such machines, most people prefer a hydro.

The incubator (Fig. 72) of which Fig. 73 is a sectional drawing, and Fig. 74 a plan, is of about thirty-six-egg capacity, and consists of a rectangular box, whose outside measurements are 26in. long, 17in. wide, and 21in. deep, made of ¾in. stuff (that is, finished thickness). The workmanship and degree of finish desired in the case, each must determine for himself according to his skill or fancy. Suffice it to say that it must be strong, and if the maker can dovetail the joints, all the better; if he cannot, French nails or screws may be used. The top, however, must be screwed, to make it removable, for facility in opening the machine if needful for repairs, and should be battened across the grain to obviate the risk of warping, to which it is liable, owing to the excessive heat to which it will be subjected.

In the upper portion of the case there is a tank, made preferably of copper or zinc, 20in. long, 11in. wide, and 12in. deep, resting on fillets of wood ½in. thick and 5in. deep, standing on the bottom and at a distance of 2in. from the two sides and back of the case. A cavity of about 2in. in width is thus left between the top of tank and the case, and all round the sides of the former and egg-drawers. This space must be filled with packing, the more non-conducting the better, as hair-felting, wadding, or gun-cotton wool, to conserve the heat. For the same reason, it is also a good plan to line the sides and top of the case with thick brown paper, using flour paste.

The tank is traversed by a flue 2in. in diameter, and standing 1in. from the three sides and the bottom. A vertical vent-shaft, or tube, 1½in. in diameter through which the wire connected with the regulator passes, is fixed to the bottom of the tank and projects 1in. through a hole in the top of the case, making its length about 16in.

The lid of the tank, through which is a hole for the vent-tube to pass, being movable, can be placed on the tank, after the latter is filled with water, the lid of the case, with its 2in. of packing fastened underneath being put on last. About 1½in. under the tank the two drawers, consisting of a framework 10in. long, 8in. wide, and 2in. deep, with a perforated zinc bottom dished towards the centre of the incubator, are placed on suitable runners. Separating the drawers there are in the centre two fillets of wood, 2in. apart and 3in. deep, the tops of which are level with the tops of the drawers. Between these an open space is provided for the regulator. The drawers, which it will be noticed are placed 1in. from the bottom of the case, thus providing space for the water-trays, slide in between the above-mentioned centre fillets and the rests for the tank.

The apertures in the case to receive the drawers and water-trays should be full 8in. wide and 3in. deep. They are closed by separate doors, not fixed to the drawers, and which must be packed like the rest of the case.

Half-a-dozen ½in. holes must be made at equal distances apart under the egg-drawers, or front of the case, for ventilation; while a hole must be provided about level with the top of the eggs between the two drawers for the insertion of the thermometer. A screw-tap at the bottom of one side of the tank would also be found useful for drawing off the water.

In this book we have described over a dozen regulators, but by far the best and most reliable is the spirit capsule (see page 44).

The T-shaped entrance-flue and the elbow outlet flue should be made separate, and passed through holes in the case into the flue in the tank, into which they should fit tightly. To prevent loss of heat by radiation, the T-shaped entrance-flue and the lamp might be encased in a metal box, or the flue could be water-jacketed, or wrapped well with non-conducting material.

In working, the heat enters at the bottom of the T-piece, and, as long as the damper is closed, passes through the tank flue, thereby heating the water, and out by the elbow-piece. When the required degree of heat is reached, by the operation of the regulator the damper lifts, and allows the surplus heat from the lamp to escape at the top of the T-piece, and at the same time the valve immediately over the vent-shaft also opens, and allows some of the heated air already in the incubator to escape.

CHAPTER XI.

THE ARTIFICIAL REARING OF CHICKENS.

To raise chicks artificially, good brooding accommodation is as essential as are good incubators, because the most profitable chicks for laying, and especially for table purposes, are brought into the world at a time when severe winter weather must be prepared for. It is also easier and more profitable to rear hundreds of chicks with suitable and convenient brooders, than dozens by the natural method. In brooding, the hen sits on the ground, the chicks nestle amongst her feathers, and are surrounded by a genial warmth. The ground also becomes considerably heated by the fowl's body. In the artificial mother, it is essential that the heat should be mainly from above, but, at the same time, the floor must not be cold and damp, or the chickens will make for the uppermost place, and the weaker ones will be trampled and crushed to death. As chicks sit down to sleep, a cold, damp floor, however warm overhead, chills them, and causes cramp and crowding. Too much bottom-heat, however, as would be the case if the source of heat were below, is a sure cause of leg-weakness. The position of the source of heat is of less importance than the necessity of its being evenly distributed, and not all in one place either top or bottom.

Heat at which to work Brooders.—Chicks should be allowed to remain in the incubator ten or twelve hours after leaving the shell—that is, until they are thoroughly dried, and have assumed their fluffy, or downy appearance, unless a warm drying box or nursery is provided with the incubator. For the first twenty-four hours, warmth is all the chicks require, the yolk absorbed into the abdomen just previously to the chick's exit from the shell, supplying all the nourishment it needs during that period. Newly-hatched chicks are practically almost naked, as their downy covering is not a very good protection against cold, and if a chick once gets chilled or stunted, it never fully recovers, and is never able to regain lost time. The temperature of the brooder should be at first about 90deg., the heat being gradually reduced to 70 or 75deg. by the end of the third or fourth week. Artificial heat should be continued during the night after it has been dispensed with during the day. Although ample warmth is very desirable—and it should be remembered that the hen broods her chicks with, approximately, the same heat with which she hatches them—the chicks when a week or ten days old, can bear a considerable amount of cold without harm, if the weather is dry and they always have at hand a warm, snug brooder to run to. If chicks are watched in cold weather it will be noticed that they do not remain out long at a time, but frequently return to the foster-mother to get warmed up again. The best criterion of the most suitable temperature at which to keep a brooder is to be found in the chicks themselves. If, instead of squatting contentedly in nearly any part of the brooder floor, they huddle together excessively, or chirp discontentedly, or have a hardness about the vent, indicating diarrhœa, the probability is that more heat is needed.

Cleanliness.—Without cleanliness, disease, death, and failure are certain. Suitable feeding troughs and drinking fountains should be provided, and food should never be left to become sour and tainted. The excrement should be frequently removed, and the floor of the brooder cleaned. Limewash, to which a little glue has been added, to give adhesiveness, should be freely used, both in coops and fowl-houses. This entails some trouble, but it is necessary, and repays the labour involved. Incubator chicks start life free from the insect pests which sap the life-blood of many hatched by hens, and if kept away from the latter, need never be troubled with vermin, and, as a consequence, they will not be liable to many of the ailments of chickens brooded by the hen.

Dampness.—Chickens can bear cold after they are a week or two old, but dampness is fatal to success at any stage of the chick's career. The floor of the brooder should be covered with sand, moss-litter, chaff, dry earth, etc., as bare boards are a fruitful source of leg-weakness. They must have a run on Mother Earth, as chicks cannot be reared altogether inside on any kind of floor. Whether the foster-mother and run are placed on grass or on dry earth, is immaterial. Each has its advantages, though the former is generally preferred. Dry earth provides better scratching exercise, supplies some food that grass does not, and can be kept sweet longer than grass, as it can be dug or hoed over from time to time. Where space is limited this is an important consideration, as grass runs need to be changed almost daily. Like fowls, chicks do better in small flocks than large ones, but the number that may be safely allowed together depends largely on the brooder. If the latter has plenty of room, with a fairly equable temperature in all parts, and if the chicks are all of one age and there are no weakly ones, fifty or more are not too many, though it is better to have two small brooders for about twenty or thirty each than one large one for fifty or sixty.

Brief descriptions of a few of the better-known foster-mothers follow.

The Metal Hen Coop Brooder (Dairy Outfit Co., King's Cross, London, N.).—This brooder (Fig. 75), as its name implies, is primarily intended for use inside a coop or shed, but it may also be used outside, except in severe weather It is made in two patterns, namely, with natural wool sides, or entirely of metal. In the first pattern the walls are porous, ensuring natural ventilation, and during the coldest weather the chickens are as warm as under the hen, this being attained without vitiating the air by unduly confining it, and without draughts. Where rats, &c., are feared the second pattern is recommended. This kind of brooder meets the desires of small rearers, and of those who prefer to rear chickens in small batches, by which method they usually thrive the best. The lamp is used without a chimney, and is wind-proof. It is enclosed within a perforated zinc guard. By means of a radiating plate the heat is brought down to the backs of the chicks.

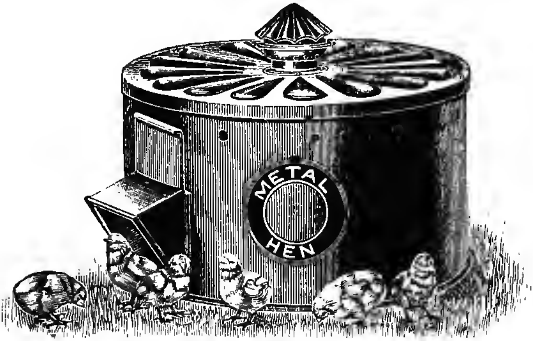


FIG. 75.—THE METAL HEN COOP BROODER.

The Metal Hen Twin-Brooder (Dairy Outfit Co.).—In this pattern there is a wire partition across the centre so that two broods can be reared at one time, or weakly chicks kept separate, or chicks of different breeds kept apart. The partition is removable, and the whole may be used as one brooder.

Various covered runs are supplied, specially suited for use with these Metal Hen brooders.

The Standard Chicken-Rearer (made by the same firm) consists of a heated chamber or dormitory from which the chicks have access by an inclined plane to an outer grass run. The walls are of double thickness, and the space between is packed. The tank is of copper, and the lamp, made as windproof as possible, is, for greater accessibility, fixed in the outer run.

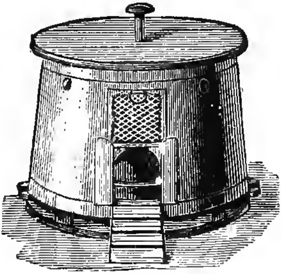


FIG. 76.—CALWAY'S REARER.

Calway's Patent Chicken Rearer (made by W. Calway, Gloucester).—In this brooder (Figs. 76 to 78) heat is radiated from an iron cone, A, enclosing a lamp, D; B is a disc to throw the heat to the sides. To increase the temperature of the rearer, open the valves (F, Fig. 77, and A, Fig. 78) towards the sides of the rearer. This reduces the openings BB (Fig. 78), thereby admitting less cold, fresh air into the cone. To lower the temperature, allow more air to pass into the heating cone by increasing the openings BB. In Fig. 77 C is the hot-air pipe and E the floor of the brooder.

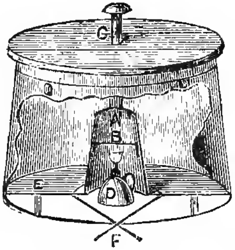


FIG. 77.—INTERIOR OF CALWAY'S REARER.

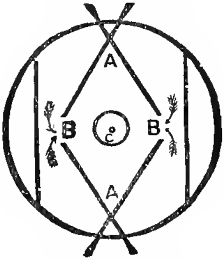


FIG. 78.—GROUND-PLAN OF CALWAY'S REARER.

Hearson's Hydrothermic Foster-Mother (Spratt's Patent, Limited, 24 & 25, Fenchurch Street, London, E.C.) consists of three chambers, viz., a sleeping compartment or dormitory, a glass-covered run, and a wire-covered run. The sleeping compartment is heated by a paraffin lamp, which burns in a windproof lantern situated at the rear, and which imparts its heat to a copper tank, filled with hot water, occupying the upper part of the dormitory. A circulating flue from the lamp heats the tank in the same way as in the hot-water incubators. Openings are provided from the sleeping compartment to the glazed run and to the wired run. A tube at the ridge of the roof of the sleeping compartment is provided for filling the tank, and an overflow tube (placed under one of the eaves) indicates when the tank is full enough. A screw plug is also provided for emptying the tank when necessary. The dormitory and glazed run have movable wooden floors. The glass in the roof is fixed in a convenient manner without putty.

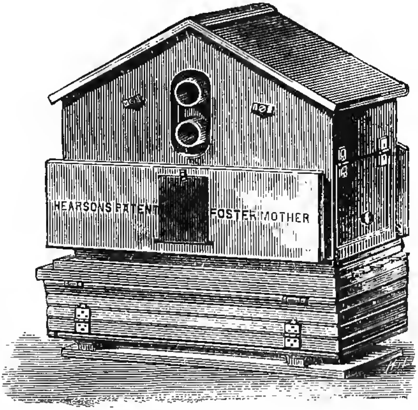


FIG. 79.—HEARSON'S HYDROTHERMIC FOSTER-MOTHER (CLOSED).

The whole apparatus can be taken apart and put together without the use of tools, and can be packed away in very little space. It is shown closed in Fig. 79, and arranged for use, with outer run, in Fig. 80.

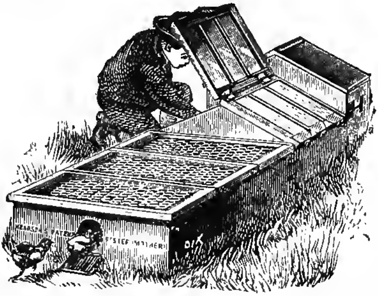


FIG. 80.—HEARSON'S FOSTER-MOTHER WITH OUTER RUN.

Hearson's Champion Foster-Mother (Spratt's Patent Ltd.).—This brooder (Fig. 81) consists of a warm sleeping compartment and a wired run. In the inner and warmer portion is a copper water-tank, which is heated by a petroleum lamp placed outside the sleeping apartment. Fresh air is supplied to the dormitory by means of a ventilating shaft which passes through the hot-water tank; thus only warm air is admitted and draughts are avoided.

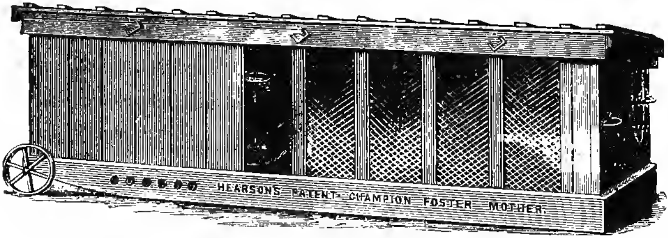

HEARSON'S PATENT CHAMPION FOSTER MOTHER.

FIG. 81.—HEARSON'S CHAMPION FOSTER-MOTHER.

The Conqueror Rearer (made by W. W. Greenwood, Bedford).—This brooder (Fig. 82) consists of two apartments, with an additional wired run, if wanted. The lamp is placed inside a wire guard. Over the lamp is a radiator, which helps to throw the heat down to the chicks. The fumes from the lamp escape by vents just under the inner lid of the sleeping apartment. The glass in the run is removable at will, and by means of handles the whole can be readily transferred to fresh ground.

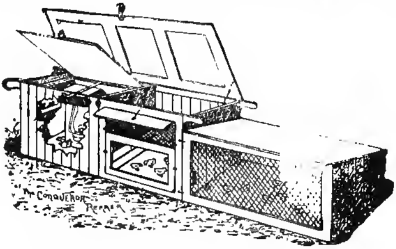


Fig. 82.—The Conqueror Rearer.

Phipps' Perfection Foster-Mother (A. E. W. Phipps, Harborne, Birmingham) is an excellently made appliance (Fig. 83), and consists of three compartments of graduated heat. It is heated by a hot-air tank.

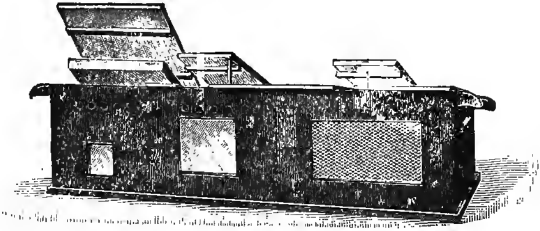


Fig. 83.—The Perfection Foster-Mother.

E. H. Taylor's Hot-water Tank Rearer (E. H. Taylor, Welwyn, Herts).—In this rearer (Fig. 84) access can be got to the chicks in the warm chamber from above. The lamp is enclosed in a wind-proof lantern in the outer netted run, which can also be glazed by fixing panes by means of turn-buttons. The walls of the sleeping place are double, and packed between.

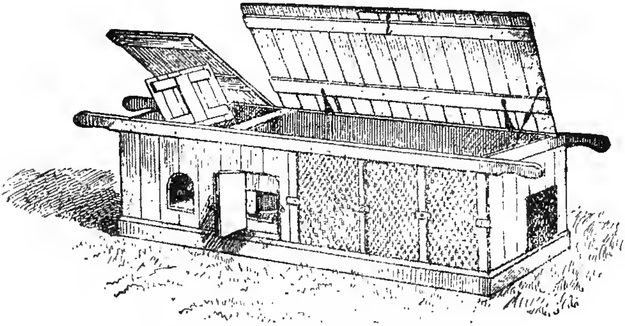


FIG. 84.—TAYLOR'S HOT-WATER TANK REARER.

The Sunbeam Chicken-Rearer (W. Tamlin, St. Margaret's, Twickenham, Middlesex) is heated by a steady supply of hot air derived from the lamp flue and tank. The rearer is of wood, well constructed, and, as in the "Nonpareil" (page 109), consists of two compartments (Fig. 85) with an inner roof to the dormitory.

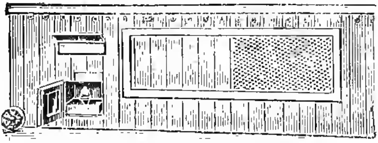


FIG. 85.—THE SUNBEAM CHICKEN-REARER.

The Nonpareil Chicken-Rearer (W. Tamlin, St. Margaret's, Twickenham, Middlesex) consists of two compartments, namely, a warm chamber and an outer run. The heat is supplied by a copper hot-water tank which covers nearly the whole of the dormitory. The lamp, with boiler to keep up the circulation of hot water in the tank, is placed in a wind-proof lantern in the outer run, and runs on a spring bottom shoe which clips it automatically into position. The rearer is fitted, as in several other rearers of this type, with handles and wheels (Fig. 86).

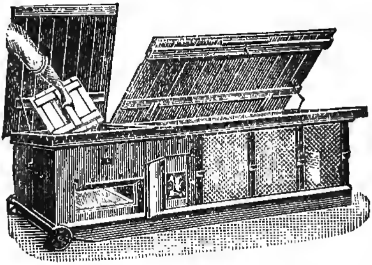


FIG. 86.—THE NONPAREIL CHICKEN-REARER.

The Cyphers A Brooder (manufactured by the Cyphers Incubator Co., 119-125, Finsbury Pavement, London, E.C.).—In this outdoor brooder (illustrated in Fig. 87), which has a floor space of 5ft. by 3ft., there are two compartments, with a third under the "hover" (a circular cover, surrounded by a fringe or lippets of felt, or other suitable material) immediately around the lamp. The front half of the brooder is reached by a runaway, or slope, and is lighted by three panes of glass. In severe weather or during the night, the front part may be closed, thus confining all the heat to the rear apartment, where the chicks are brooded under the circular hover, with heavy fringed curtain, previously mentioned. During the daytime, the runaway can be let down, when the heavy woollen curtain retains most of the heat in the rear compartment.

This brooder is heated by a stove passed under the floor, which is protected underneath by a sheet of galvanised iron, with an air space between it and the floor above. By means of the sliding board on which the lamp is placed, it is easily pulled out and replaced. By the aid of a mirror placed on the left side, the size of the flame may be ascertained; and by means of the long spindle to the lamp the wick may be raised or lowered without opening either lamp door or brooder.

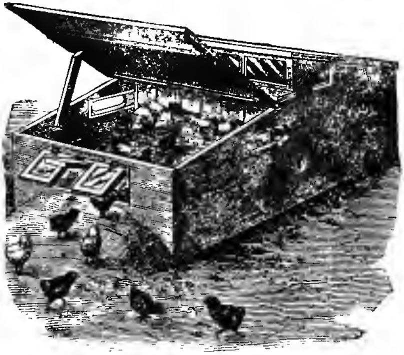


FIG. 87.—THE CYPHERS A BROODER.

The Prairie State Outdoor Brooders, Style C. (Prairie State Incubator Co.; British Representative, Robt. A. Colt, Ltd., 8 and 9, Chiswell Street, E.C.).—These are made in two sizes—3ft. square and 4ft. square—and have span-roofs. The lamp is placed at one end, where it is in sight and easily accessible. The heat is applied on much the same principle as in the Prairie State Incubators. A flue from the lamp conducts the heat into a radiator, which forms the top of the hover. Under the bottom of the radiator, at a distance of about half-an-inch, is wire gauze, which prevents the chicks from crowding up under the hover, and allows a constant circulation of air over their heads.

The lamp is enclosed in a case, which protects it from the wind. The cold-air pipe supplying the lamp does not enter the lamp case direct from outside, where it would be affected by draughts, but draws its air from inside the brooder, thus assisting in keeping up a constant circulation. The heating device is similar in principle to that of the ordinary tubular hurricane lantern, the fumes from the flame of which are drawn, mixed with outer air, from the dome at the top of the chimney into the tube on each side of the chimney, through which they are again drawn downwards into the flame. The roof of the brooder is of galvanised iron and glass. The entire brooder may be taken to pieces for storing away.

An indoor brooder and a cheaper outdoor brooder (Style O) are also made by this firm, both similar in principle to the one described.

The Rising Sun Brooder (Randolph Meech, Poole, Dorset) has two compartments (Fig. 88), with a movable floor to each. The front of the run is of half-inch wire netting, with removable glass panes for very cold weather. The cover in the dormitory stands immediately above the heat-drum, and is heavily curtained. This heat-drum is large and of cast-iron. Under the wooden floor is an iron plate separated from this wooden floor by a 1¼in. cavity, which prevents the fumes of the lamp from getting into the chick-chamber, and the floor from becoming overheated. A current of air passes between the iron plate and the wood floor when the lamp is lit, circulates round the heat-drum, and passes through the perforated zinc guard round the heat-drum into the centre of the nest. This prevents overcrowding, and only pure warmed air enters the brooder. A ventilator is provided on the top of the hover.

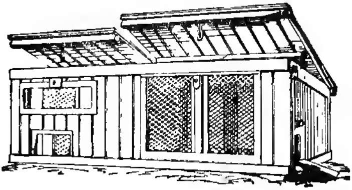


FIG. 88.—THE RISING SUN BROODER.

A strong lamp is supplied with a long spindle allowing for the adjustment of the flame from the outside. Many well-considered details add to the convenience of operating this brooder.

The Wooden Hen Brooder (by the same maker) is similar in construction to the preceding, but is smaller, being intended for smaller batches of chickens.

The Gloucester Brooder (The Incubator Components Manufacturing Co., Gloucester) has two compartments, with the hover or central sleeping chamber forming a third, much in the same way as in the Phœnix Brooder (pp. 113-115). A pipe brings heated fresh air from below the floor into the centre of the hover, which is surrounded by heavy lappets. The hover is provided with a thermometer, the temperature of which can be seen at a glance, and in the centre is an adjustable ventilator. The lamp is fitted with a chimneyless burner, and the wick can be turned up or down without removing it from its position. It is storm-proof and provided with a safety-shield to prevent the oil from becoming over-heated. All the interior parts are movable, so that the floors and heating apparatus can be removed for cleaning.

Shaw's Scientific Hen Foster-Mother (William Lea. Royal Appliance Works, Birkdale, Southport).—This brooder (Fig. 89) is strongly made and of convenient size. The lid of the brooder slides either way. In the lid there is a small slide to use when taking out or replacing the lamp in the heater, so that it is not necessary to remove the whole lid for this purpose. The heater is fixed and consists of three cones. The lamp is passed through the above-mentioned opening in the lid into the heater. The fumes are directed through the double compartments of the heater, travel downwards to the circumference, then ascend to the apex and pass out into the outer air. A supply of fresh air circulates around the lamp cistern, tending to keep the oil cool, and in passing upwards becomes warmed by the conical heater.

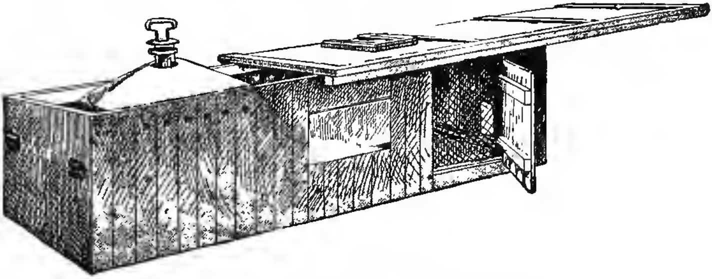


FIG. 89.—SHAW'S SCIENTIFIC HEN FOSTER-MOTHER.

The Phœnix Outdoor Brooder (H. W. Stephens, Calton Road, Tuffley, Gloucester) is 6ft. 6in. long by 3ft. wide, and in it the chicks have a choice of three temperatures. The heating arrangements and floors are removable for cleaning. The heat is derived from a lamp which slides under the centre of the heat drum. The lamp is provided with a safety shield to prevent its becoming over-heated. Under the wooden floor of the warm chamber is a large sheet of galvanised iron to obviate danger of fire or fumes from the lamp getting into the chick chamber. A supply of fresh air enters from outside the brooder: passing through the iron and wood floors it comes in contact with the heat drum, and, getting warm, it passes up inside the wire guard in the centre of the hover, where it is distributed over the backs

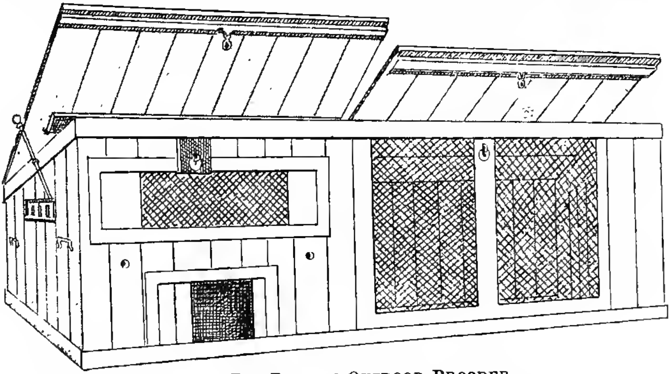


FIG. 90.—THE PHŒNIX OUTDOOR BROODER.

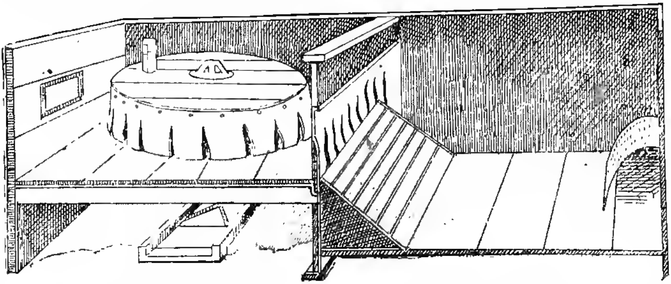


FIG. 91.—THE PHŒNIX OUTDOOR BROODER—INTERIOR.

of the chicks. A reliable thermometer is provided, which is so placed that it can be read from the outside. The Phœnix Brooder is shown in Figs. 90 and 91.

The Glevum Brooder (Horace W. Stephens, Calton Road, Tuffley, Gloucester) is 6ft. long by 3ft. wide, and has double walls. The interior is in two compartments, each 3ft. by 3ft. In the nursery portion one-half of the space is occupied by the hover. The heat is derived from a cold-air flush lamp, which takes its air from the inside of the brooder through a galvanised iron pipe, so that the lamp is protected from the outside wind, effective circulation being kept up by means of sliding ventilators at the top of the sides. Beneath the hover there is a constant supply of fresh air, which has become warmed by contact with the flue. The lamp is placed under the left-hand side of the brooder, the heat being carried up through a flue into the radiator, which forms the top of the hover, and there it is evenly diffused over the hover. Half an inch from the bottom of the radiator is fixed a piece of wire gauze, which prevents the chicks from coming in contact with the hot radiator, and allows a circulation of air above their heads.

Sectional Brooders are of American design, and intended for use where large numbers of chicks are to be reared. They, of course, require a suitable house in which to operate them. They are made generally 6ft., 9ft., or 12ft. in length, and about 3½ft. wide, each 6ft. length being divided into two 3ft. sections, each to accommodate 100 chicks. The lamps, placed at the end, heat a hot-water tank, creating a current of heated water through pipes from the tank along the top of the brooder and back to the tank again. These brooders, as shown in Fig. 92, are made by Randolph Meech, and Prairie State indoor brooders are imported by Robt. A. Colt, Ltd.

In the former, the separate lids to each section of the brooder are fitted with adjustable ventilators. The wire-netted panels over the feeding places are provided with movable glass for use in winter.

In all these brooders the floor may be raised nearer the heated pipes, or lowered, according to the size of the chicks.

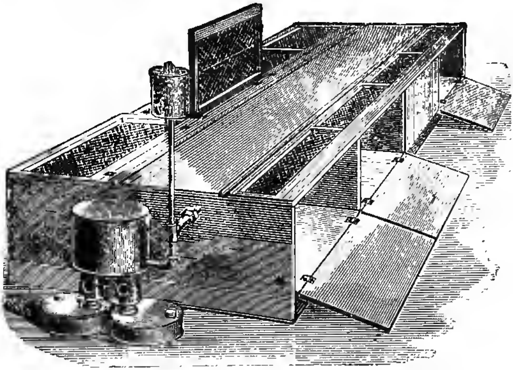


FIG. 92.—SECTIONAL BROODER OF AMERICAN DESIGN.

Brooding-Houses, in which to place sectional brooders, when other suitable accommodation is not at hand, are made by Randolph Meech, Poole.

Safety Brooder Stove (The J. B. Everall Manufacturing Co., Hayes, Middlesex).—With a stove of this description (Fig. 93) the making of a serviceable brooder is a comparatively simple matter. The heating power is two or three times that of an ordinary brooder lamp; it can be fitted into any convenient-sized home-made brooder, and is safe and reliable. The body or reservoir is made of strong patent coated metal. A large safety water space, one and a half inches deep, is provided, holding nearly a quart of water, covering the whole of the top of the oil reservoir and keeping the oil cool, thus preventing the generation of explosive gases, which are a source of danger in flimsy lamps fitted with cheap burners. A small safety tube is provided alongside and level with the wick tube, so that should any gas be generated, as is often the case when low-grade oil is used, this contrivance affords a safe means of escape for it.

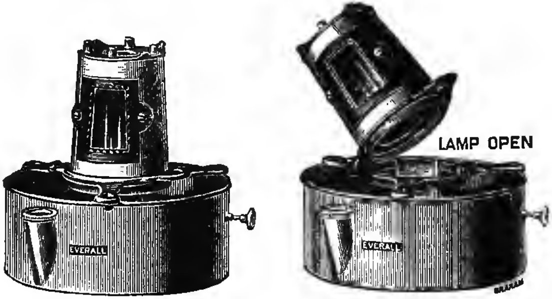


FIG. 93.—SAFETY BROODER STOVE.

As cleanliness is so essential in chicken-rearing and poultry-keeping, **Everall's Gem Spray Pump** (The J. B. Everall Manufacturing Co., Hayes, Middlesex) (Fig. 94) is exceedingly useful in keeping coops and houses sweet and sanitary in a manner that far supersedes the brush. Any place can be limewashed with the above appliance more effectually and quickly than with the brush. It can be also used for spraying disinfectants. It has a gun-metal nozzle, adjustable to throw a solid jet a considerable distance with great force, or a coarse or fine spray, enabling cracks or crevices to be reached that could not be touched by the brush.

The cylinder is of brass, furnished with an air-chamber for maintaining a continuous stream. By means of an adjustable foot-bracket for steadying the pump in the pail, both hands are left at liberty. There is a perforated brass strainer, to keep the contents of the pail in motion and well mixed. The pump may be used for spraying trees or plants or washing windows, &c. The valves being of metal do not clog or choke, even with foul or gritty matter.

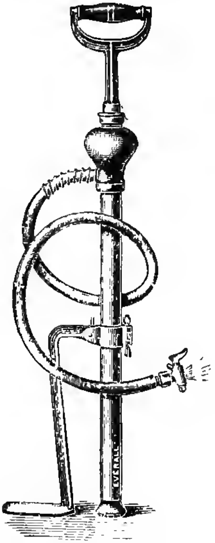
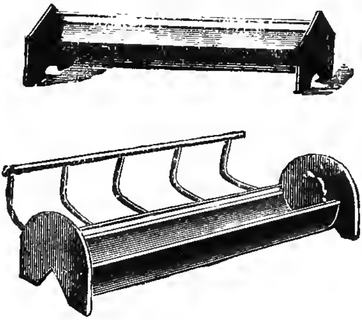


FIG. 94.—GEM SPRAY PUMP, FOR LIMEWASHING OR DISINFECTING COOPS AND HOUSES.

The Mistmaker Spray Nozzle, made by Randolph Meech, produces a penetrating mist-like spray with low pressure, and is useful in many ways on a poultry farm.

Grinding and Kibbling Mills. — To facilitate the preparation of dry broken grain, &c., in preference to moistened meals for feeding chicks, there are several small and handy kibbling or crushing mills on the market. These are sold by several poultry appliance makers. The "Bentall" Grinding and Kibbling Mill, made by E. H. Bentall and Co., Heybridge, Maldon, Essex, is fitted with patent flexible grinding plates, which, being self-adjusting in all directions, run true one with another, thus ensuring an even sample of grinding. This mill may be adjusted to grind to a meal, or to kibble or crush all kinds of grain, coffee, drugs, charcoal, broken shell, dog biscuits, &c. By the smaller of the two mills made by this firm, 30lb. or more of grain may be kibbled in an hour.



Figs. 95 and 96.—Feeding-troughs.

The Mistmaker Spray Nozzle. — The maker of this appliance should have been given as J. B. Everall, Battersea Works, Hayes, Middlesex.

Incubators, Page 118.

these two meals by lamplight. For the first day or two feed the chicks on any of the following:—(1) Hard-boiled eggs (unfertile ones removed from an incubator will do for this purpose) chopped fine, shells included, with an equal quantity of stale breadcrumbs, moistened, and mixed into a friable condition with milk; (2) Coarse, dry oatmeal; (3) Stale breadcrumbs, dry or moistened, but not made sloppy, with milk or water. After the first few days any of the following may be substituted, and the more the food is varied the better; (4) One-third oatmeal to two-thirds barley-meal, scalded with boiling water and mixed into a crumbly condition; (5) Five parts oatmeal to one of boiled rice, mixed as No. 4; (6) Boiled rice mixed into a friable state with any meal. This is a good food for checking diarrhœa. The chicks should be early accustomed to crushed wheat, and afterwards to whole grain.

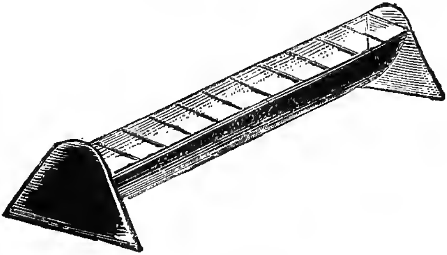


FIG. 97.—TAMLIN'S FEEDING-TROUGH.

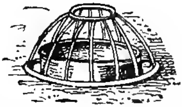


FIG. 98.—FEEDING-TROUGH WITH MOVABLE WIRE GUARD.

Bran should be scalded to soften it, otherwise it is very indigestible and irritates the bowels. When scalded it is an excellent bone-forming food. Some animal food and an abundance of green food are necessary from the first week, but the former should be chopped fine. Feed regularly, giving as much as the chicks will eat, and afterwards removing what is left. Grit or sand should be scattered on the food, and a dry dust-bath must not be forgotten. The accompanying drawings (Figs. 95 to 100) show suitable designs of feeding-troughs, which prevent waste, as the chicks cannot trample their food. The

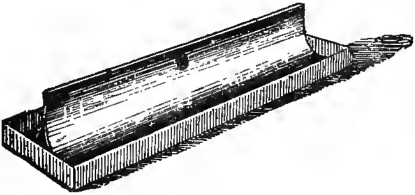


FIG. 99.—A SIMPLE FEEDING-TROUGH.

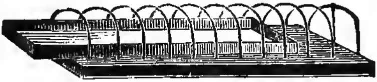


FIG. 100.—GREENWOOD'S FEEDING-TROUGH.

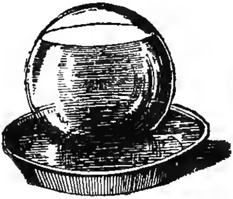


FIG. 101.—AUTOMATIC DRINKING FOUNTAIN.

troughs illustrated in Figs. 95 and 96 are easily cleaned; in Figs. 97 to 100 trays in which the food is placed slide out at one end; in Fig. 98 the wire guard is removable; and in Fig. 99 the inner portion of the trough may be lifted out.

Fig. 101 shows an automatic drinking-fountain for chicks. It consists of a glass globe and a metal saucer. The globe is filled with water, the saucer is fitted over the opening in the former, and the whole is then inverted. As the water in the saucer is drunk that in the globe gradually descends to take its place. The fountain illustrated in Fig. 102 is similar in its action.

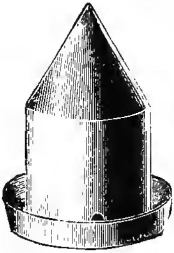


FIG. 102.—AUTOMATIC DRINKING-FOUNTAIN

Feeding-troughs of good design, with triangular ends, are sold by the Prairie State Co. They are made of wood, in three different sizes—18in., 24in., and 30in. The chickens cannot get into the troughs to scratch out the food, nor can they knock the troughs over.

Where chicks are fed with older stock, as is very often the case, unless some such appliances as the following are used, the younger birds do not get a fair or sufficient share of the food provided, or they are driven away till the older birds are satisfied. It is necessary, also, that young stock be fed oftener than, and with different food from, adult stock.

Boulton and Paul's Feeding Coop (Boulton and Paul, Ltd., Norwich) supplies a want. Food placed under the cage (Fig. 103) is protected from rain or sun and is accessible to chicks only. By moving the coop daily, danger from tainted ground is obviated. The chick openings may be partially closed to suit chicks of any size desired.

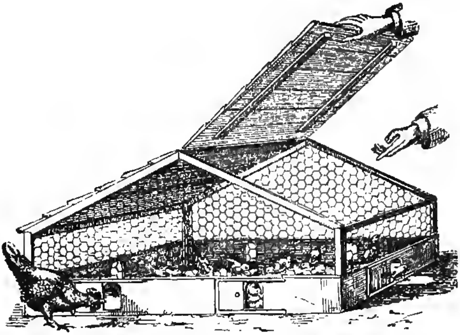


FIG. 103.—BOULTON AND PAUL'S FEEDING COOP.

Pascall's Chick-feeding Run (Boulton and Paul, Ltd., Norwich) is another appliance for the same purpose. The illustration (Fig. 104) is sufficiently self-explanatory.

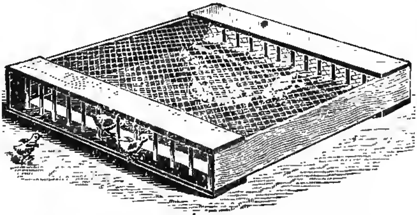


FIG. 104.—PASCALL'S CHICK-FEEDING RUN.

Care should be taken to keep everything connected with chicks

—the coops, runs, feeding appliances, &c.—very clean. In case of chicks dying, they should be burnt, or buried deeply, as most ailments are more or less infectious.

Chicks grow hardier and thrive at least as well if fed entirely on dry food. This method of feeding is much less trouble and more economical. As dry food, the following are all that are required: Millet-seed, canary-seed, groats, cracked peas, and hemp-seed. The following are good mixtures: 3 parts millet, 3 parts canary, 2 parts finely-cracked peas, 1 part hemp-seed. A second mixture may consist of 3 parts canary, 3 parts groats, 2 parts hemp-seed, 1 part cracked peas. Groats and canary-seed may be given separately if desired, but a blend of seeds, as above, is better.

When the chicks are about a month old, finely-broken rice, wheat, maize, and rough oatmeal may be added with advantage. Give the chicks daily a little finely-chopped lean meat, unless they have access to plenty of insect life. An abundance of garden vegetable waste, if at hand, and quite fresh, is excellent, but should be chopped finely. Do not give the chicks more food at a meal than they will eat up, so that none is left to become tainted, and injure them. Feed often in small quantities.

Provide the chicks cover for cold and damp weather. A sack supported on sticks will answer in the absence of a better arrangement. Under the shelter provide chaff, in which has been scattered a little cracked grain to induce exercise. Stir the chaff or other litter up frequently, and replace when damp.

To cure diarrhœa, caused by wrong feeding or cold, place a little camphor in the drinking-water, and give a meal or two of cooked rice, strained as dry as possible.

Chicken Boxes, for conveying newly-hatched chicks by rail are made by many firms. These are of light, thin wood, ventilated by about six holes, or of strawboard, which may be packed flat. The latter are lighter, quite as strong, and being collapsible, are more convenient. Wm. Tamlin, St. Margaret's, Twickenham, Middlesex, and the Dairy Outfit Co., King's Cross, London, N., amongst other firms, supply strawboard chick-carriers.

Randolph Meech's Chicken Boxes (Poole, Dorset) are made of light wood, being 10½in. long, 6½in. wide, and 5½in. high, for twelve chicks, and are ventilated. If a piece of felt is placed in the bottom, and a piece of flannel hung loosely above the chicks, and the chickens are packed fairly close, they can bear a long journey in the coldest weather without injury.

The best time to send chickens away is immediately after hatching, as the undigested yolk still in the abdomen provides the chick with all the food it needs for the first twenty-four hours or so after hatching.

CHAPTER XII.

EGG-TESTERS AND EGG-BOXES.

The Jersey Egg-tester (Fig. 105) consists of a circular metal box, with an opening in the top large enough to hold an egg, and an opening in the side fitted with a funnel-shaped tube, through which the egg is examined. Inside the box, placed at an angle of 45deg., is a mirror. The light from above passes through the egg, and is reflected from the obliquely-placed mirror through the inspecting tube.

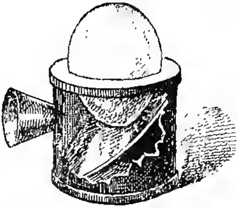


FIG. 105.—THE JERSEY EGG-TESTER.

Hearson's Champion Egg-testing Lantern (Spratt's Patent, Limited) meets the difficulty of obtaining a very strong beam of light without overheating the eggs. As we approach a flame the light increases, but so also does the heat. In this egg-testing lantern a globe of water is introduced between the flame and the egg (Fig. 106); this effects the double purpose of concentrating the light and stopping the heat rays. The egg-tester having been fitted with a diaphragm suitable in size to the eggs to be tested, should be held in the left hand in front of the lantern so that the egg, which is held between the forefinger and thumb of the right hand close to the diaphragm, intercepts the light; the contents are then clearly seen.

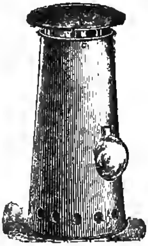


FIG. 106.—HEARSON'S CHAMPION EGG-TESTING LANTERN.

Egg-boxes, for parcel post or rail.—A large trade is done in sending eggs by parcel post and rail, and as it is absolutely necessary that breeders should pack their eggs safely, and in such a manner as to withstand injury from the necessary shaking to which they are subjected in transit, several kinds of boxes have been put on the market claiming to answer this purpose. If ordinary boxes are used, they should be plenty large enough, and the eggs are better packed in hay, as chaff and similar packing is apt to shake into one end of the box, leaving the eggs touching each other, and consequently liable to fracture, in the other end.

Pocock's Patent Egg-boxes (Dairy Outfit Co., King's Cross, London) are designed to supply the need of an absolutely safe transit box for valuable eggs for incubation. The interior fittings are of felt, which counteracts the injurious effects of jarring concussion. Each egg swings in a hammock of felt, held firmly in position when the box is closed. Felt being a non-conductor of heat, these boxes are specially adapted to hot climates. They are made in all sizes to accommodate from one to eighty dozen eggs.

Fanciers' Cosy Egg-boxes (Dairy Outfit Co., King's Cross).—This is a reliable, non-returnable box, and as low in price as is consistent with safety. Instead of single partitions, the divisions are of double cardboard, providing, as it were, a self-acting cushion against every egg. Owing to these double divisions, the spaces between adapt themselves to eggs of different sizes; in fact, large and small ones may, if needful, go with safety in the same box. The top and bottom of the box may be packed with hay, but thick cotton pads are provided for this purpose, if desired. All boxes above the two-dozen size are provided with handles. The inside patent fittings are also sold separately.

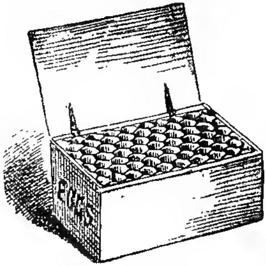


FIG. 107.—ROBINSON'S PATENT HONEYCOMB EGG-BOX.

Robinson's Patent Honeycomb Egg-box (Robinson's Patents, 332, Goswell Road, London, E.C.) (Fig. 107) is constructed on the principle of the honeycomb cell. More eggs can be packed in a given space than in boxes which are arranged with squares. The cells are made of patent leather-board, and between each layer of eggs is placed a piece of felt. The boxes are made of yellow pine, or canary wood, and have dovetailed corners. The Honeycomb box is also made with cells to admit ducks' or turkeys' eggs.

The Anti-Smash Egg-box (Robinson's Patents, Ltd., 332, Goswell Road, London, E.C.) embraces a principle that provides the maximum of protection. Each egg rests in a flexible and bottomless cup, whilst the top half of the egg is covered with a corresponding cup (Fig. 108). Thus, though the boxes are light, they will resist the roughest usage, and being made in all sizes they are suitable for sending away sittings or large quantities of eggs to market.

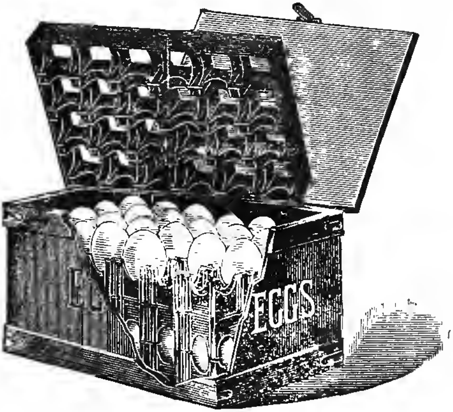


FIG. 108.—THE ANTI-SMASH EGG-BOX.

Tamlin's Cellular Egg-boxes are made of double strawboard, with corrugated strawboard between. The divisions between the eggs are of the same material. This double corrugated strawboard gives great strength with lightness and elasticity.

Baker's Patent Spring-bottom Egg-box (Spratt's Patent, Limited) is a box of suitable size for the number of dozens intended to be carried (Fig. 109). The partitions are of strawboard as in other egg-boxes, but in this, under the bottom layer of eggs, coiled springs are fixed which very effectually prevent breakage.

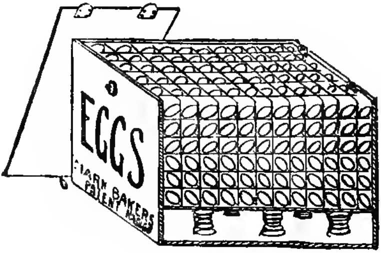


FIG. 109.—BAKER'S PATENT SPRING-BOTTOM EGG-BOX.

Tamlin's Farmer's Egg-box (Fig. 110) is a strong box with iron-bound corners. The partitions are of corrugated strawboard. There is also a layer of the same strawboard between each layer of eggs.

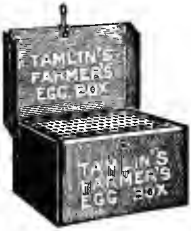


FIG. 110.—TAMLIN'S FARMER'S EGG-BOX.

The Glevum Pedigree Egg-trays (H. W. Stephens, Calton Road, Tuffley, Gloucester).—These are for the use of incubator operators who wish to know the pedigree of their chickens. The eggs should be incubated in the ordinary trays up to the time when the chickens begin to "pip" (*i.e.*, to fracture the shell with their beaks), when they should be sorted out according to the marks on the eggs, and placed in the separate compartments of the pedigree trays (Fig. 111). As the chicks hatch they fall down between the rounded slats into the compartments below, where it is impossible for them to get together. When in these compartments, the same as in the ordinary nursery, the chicks are at the proper temperature of about 90deg. to 95deg.

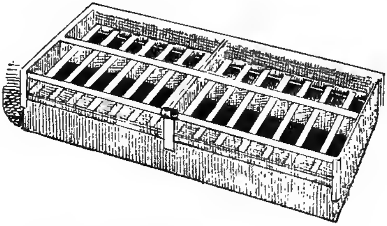


FIG. 111.—GLEVUM PEDIGREE EGG-TRAY.

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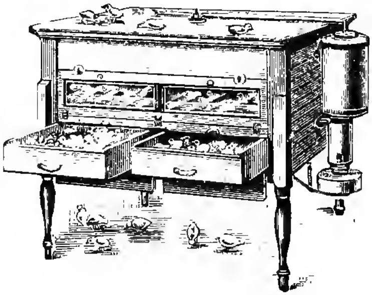

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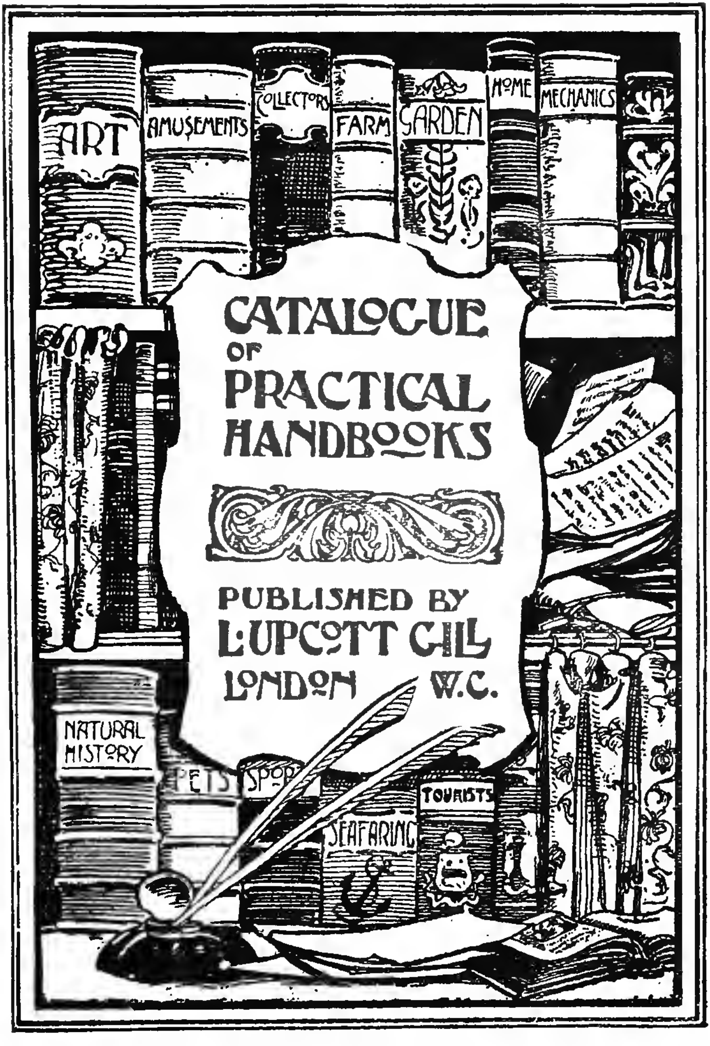

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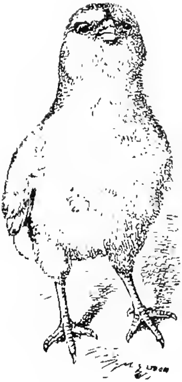

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